

25 PARK PLACE – PHASE TWO

GEORGIA STATE UNIVERSITY

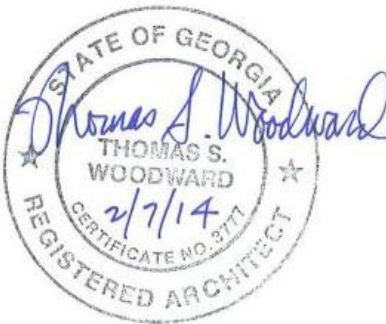
BOARD of REGENTS of the
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PROJECT MANUAL

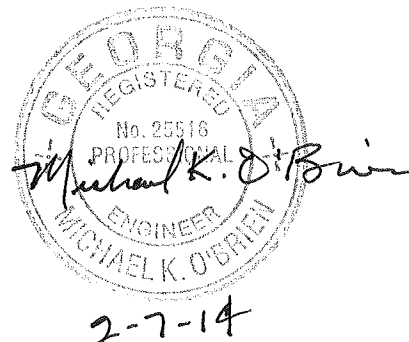
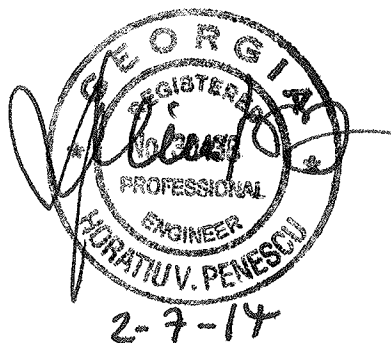
100% CONSTRUCTION DOCUMENTS

GSU Project Number: 080-096-13

February 7, 2014



Heery International, Inc.
999 Peachtree Street NE
Atlanta, GA 30309-3953
Commission No. 12053-02



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Not Used

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Not Used

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT

- A. Project Name: 25 Park Place – Phase 2.
- B. Owner's Name: Georgia State University.
- C. Architect's Name: Heery International, Inc.

1.2 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is shown on drawings and specified in Section 024100.
- B. Scope of alterations work is shown on drawings.
- C. Contractor shall remove and store the following prior to start of work, for later reinstallation by Contractor:

1.3 OWNER OCCUPANCY

- A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.
- B. Owner intends to occupy the Project upon Substantial Completion.
- C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- D. Schedule the Work to accommodate Owner occupancy.

1.4 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
 - 3. Work by Owner.
 - 4. Use of site and premises by the public.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Existing building spaces may not be used for storage.
- E. Utility Outages and Shutdown:
 - 1. Limit disruption of utility services to hours the building is unoccupied.
 - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
 - 3. Prevent accidental disruption of utility services to other facilities.

PART 2 - PRODUCTS

2.1 GEORGIA-BASED MATERIALS AND PRODUCTS

- A. All major facility projects shall include Georgia products such that not less than 10 percent of all building materials used in a project are harvested, extracted, or manufactured in the State of Georgia where such products are commercially available. The following sections of the Official Code of Georgia Annotated (O.C.G.A) contain laws referencing the purchase of Georgia products. Additional information regarding these laws may be obtained through the Department of Administrative Services.
1. 50-5-[60-61] "Preference for Georgia Supplies, materials, equipment and agriculture products."
 2. 50-5-62 "Preference for Local Sellers of Georgia Products".
 3. 50-5-63 "Preference for Georgia Forest Products"

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 024100 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Selective demolition of building elements for alteration purposes.
- B. Abandonment and removal of existing utilities and utility structures.

1.2 RELATED REQUIREMENTS

- A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

1.3 REFERENCE STANDARDS

- A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2009.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
 - 1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
 - 2. Identify demolition firm and submit qualifications.
 - 3. Include a summary of safety procedures.
- C. Project Record Documents: Accurately record actual locations of any capped and active utilities encountered and subsurface construction.

1.5 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of five years of documented experience.

1.6 PROJECT CONDITIONS

- A. Minimize production of dust due to demolition operations and erect temporary barriers to prevent passage of dust to adjacent occupied areas.
- B. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 - PRODUCTS -- NOT USED

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- B. Do not begin removal until receipt of notification to proceed from Owner.
- C. Do not begin removal until built elements to be salvaged or relocated have been removed.
- D. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- E. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- F. Perform demolition in a manner that maximizes salvage and recycling of materials.
 - 1. Dismantle existing construction and separate materials.
 - 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

3.2 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.

- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.3 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as shown.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Separate areas in which demolition is being conducted from other areas that are still occupied.
 - 1. Provide, erect, and maintain temporary dustproof partitions of construction indicated on drawings.
 - 2. Provide sound retardant partitions of construction indicated on drawings in locations indicated on drawings.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
- D. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
 - 2. Remove items indicated on drawings.
- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. See Section 011000 for other limitations on outages and required notifications.
 - 4. Verify that abandoned services serve only abandoned facilities before removal.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- F. Protect existing work to remain.
 - 1. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - 2. Repair adjacent construction and finishes damaged during removal work.
 - 3. Patch as specified for patching new work.

3.4 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 057210 - GLASS RAILING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Stainless steel handrails, top cap and fittings. (Base Bid)
- B. Aluminum handrails, top cap and fittings. (Alternate #1)
- C. Glass infill system.

1.2 REFERENCES

- A. ASTM C1048 - Standard Specification for Heat Treated Flat Glass, Coated and Uncoated Glass.
- B. ASTM E 488 - Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
- C. ASTM E 985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
- D. NAAMM AMP 510 - Metal Stairs Manual; 1992, Fifth Edition.
- E. SSPC Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); 1982 (Ed. 2000).

1.3 SUBMITTALS

- A. Submit under provisions of Section 013000 - Administrative Requirements.
- B. Manufacturer's product data substantiating compliance with Contract Documents. Include manufacturer's installation instructions.
- C. Shop Drawings: Submit Shop Drawings for stairs and railings.
 - 1. Include plans, elevations, and details.
 - 2. Show connection and accessory items and locations for anchor and bolt installation.
 - 3. Include design loads, structural calculations, and material properties.
 - 4. Provide Shop Drawings signed and sealed by structural engineer licensed in the state in which Project is located.
- D. Railing Sample: Five 12 inch long Sample illustrating color, finish, sheen, and concealed connection detail.
- E. Glass Sample: Submit five 12 inch by 12 inch size glass illustrating color, thickness, and edge conditions.
- F. Supply installation templates, required reinforcing, and recessed anchorage devices in timely fashion to installers of related work that will receive products of this section.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
 - 1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
 - 2. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."

- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.
 - 3. Glass-Supported Railings: Support each section of top rail by a minimum of three glass panels or by other means so top rail will remain in place if any one panel fails.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Work of this section shall be designed, fabricated, shipped and installed by a single source company that has specialized in ornamental handrails and railings with ten years minimum experience.
- B. Installer Qualifications: Installation shall be performed by the fabricator or a company acceptable to the fabricator.
- C. Safety Glazing Labeling: Permanently mark glass with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store in a weather tight location and protect from corrosion, distortion, and other damage during delivery storage and handling.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer:
 - 1. Julius Blum & Co., Inc.: www.juliusblum.com
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Stainless Steel Tubing: ASTM A554, Type 304.
- B. Stainless Steel Bars, Shapes, and Moldings: ASTM A276, Type 304.
- C. Aluminum Tubing: ASTM B221 (B221M) extruded tubes, Alloy 6063-T52.
- D. Aluminum Reinforcing: ASTM B221 (B221M) extruded shapes, Alloy 6061-T6.
- E. Aluminum Bars, Shapes, and Moldings: ASTM B221 (B221M) extruded shapes, Alloy 6063-T52.
- F. Glass: Tempered glass complying with ASTM C 1048.

2.3 GLASS RAILING SYSTEM

- A. Glass: Tempered float glass, Kind FT (fully tempered), Condition A (uncoated), Type 1 (transparent flat glass), Quality Q3. Thickness as required for installation design loads. Provide products that have been tested for surface and edge compression according to ASTM C 1048 and for impact strength according to 16 CFR 1201 for Category II materials.
 - 1. Glass Color: Clear.
 - 2. Thickness: As indicated on Drawings.
- B. Top Rail: Channel tubing as indicated on the drawings, with matching welded miter corners, end caps, and internal splice connectors.
 - 1. Material: Satin finish stainless steel; 16 gage, 0.065 inch. J. Blum #1452.
 - a. Diameter: 2-1/2 inch.
 - 2. Material: Clear anodized aluminum.
 - a. Size: 2-1/2 inches diameter; 0.125 inch thickness. J. Blum #1132.
- C. Shoe: J. Blum #1142.
- D. Handrails: Metal tubing handrail fastened to glass balusters at heights indicated with glass-mount adaptor kit, J. Blum #224.
 - 1. Material: Satin finish stainless steel, 1 1/4 inches diameter.
 - 2. End Caps: Match handrails.
 - 3. Brackets: J. Blum #275.
 - 4. Dimensions and Configurations: As indicated on Drawings.

2.4 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Aluminum Components: Type 304 stainless-steel fasteners.
 - 2. Stainless-Steel Components: Type 304 stainless-steel fasteners.
 - 3. Dissimilar Metals: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.
- D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.5 GLASS AND GLAZING ACCESSORIES

- A. Glazing Cement and Accessories for Structural Glazing: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal subrails.
 - 1. Glazing Cement: Nonshrinking organic cement designed for curing by passing an electric current through metal subrail holding glass panel, as standard with manufacturer.
- B. Glazing Gaskets for Glass Infill Panels: Glazing gaskets and related accessories recommended or supplied by railing manufacturer for installing glass infill panels in post-supported railings.
- C. Allow 1/2 inch clearance between glass panels.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- F. Connections: Fabricate railings with nonwelded connections unless otherwise indicated.

2.7 GLAZING PANEL FABRICATION

- A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
 - 1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces
 - 2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
- B. Infill Panels: Provide tempered glass panels for straight sections.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.9 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Mechanical Finish: AA-M32 Medium Satin Mechanical Finish as specified; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 180- and 220-grit aluminum oxide abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.
- C. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.10 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Directional Satin Finish: No. 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.

- B. Verify that reinforcement and anchoring devices are the correct type, have been located correctly, and have been installed properly.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

- A. Install ornamental railings plumb and level and in full accordance with manufacturer's instructions.
- B. Locate railings as indicated on Drawings and at heights that are in accordance with applicable code.
- C. Anchor to substrates in strict accordance with tested anchorage system, free from distortion or defects detrimental to appearance or performance.
- D. Maximum variation from plumb shall be 1/4 inch.
- E. Maximum offset from true alignment for every 50 foot of railing shall be 1/4 inch, non-accumulative.

3.3 CLEANING AND PROTECTION

- A. Remove manufacturer's protective coverings from exposed surfaces after installation.
- B. Clean surfaces using materials and methods as recommended by manufacturer.
- C. Protect finishes from damage during construction period with temporary protective coverings acceptable to the manufacturer.
- D. After installation of system is complete, advise General Contractor of methods necessary for protection until Substantial Completion.

END OF SECTION

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Preservative treated wood materials.
- B. Fire retardant treated wood materials.
- C. Communications and electrical room mounting boards.
- D. Concealed wood blocking, nailers, and supports.

1.2 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.3 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010
- C. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2009a.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.
- E. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood Protection Association; 2003.
- F. AWPA C9 - Plywood -- Preservative Treatment by Pressure Processes; American Wood Protection Association; 2003.
- G. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Protection Association; 2003.
- H. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Protection Association; 2002.
- I. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood Protection Association; 2010.
- J. PS 1 - Structural Plywood; 2007.
- K. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.
- L. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002.
- M. WWPA G-5 - Western Lumber Grading Rules; Western Wood Products Association; 2011.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.
- C. Samples: For rough carpentry members that will be exposed to view, submit five samples, illustrating wood grain, color, and general appearance.
- D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
 - 2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
- B. Lumber fabricated from old growth timber is not permitted.
- C. Provide sustainably harvested wood; see Section 016000 for requirements.
- D. Provide wood harvested within a 500 mile radius of the project site; see Section 016000 for requirements for locally-sourced products.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.

- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.3 CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- B. Other Applications:
 - 1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
 - 2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
 - 3. Other Locations: PS 1, C-D Plugged or better.

2.4 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Drywall Screws: Bugle head, hardened steel, power driven type, length to achieve full penetration of sheathing substrate.
 - 3. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.5 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWPA standards.
- B. Fire Retardant Treatment:
 - 1. Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
 - b. Hoover Treated Wood Products, Inc: www.frtw.com.
 - c. Osmose, Inc: www.osmose.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
 - 2. Interior Type A: AWWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated .
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

- C. Preservative Treatment:

1. Manufacturers:
 - a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
 - b. Viance, LLC: www.treatedwood.com.
 - c. Osmose, Inc: www.osmose.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
 1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 2. Treat lumber in contact with masonry or concrete.
 3. Treat lumber less than 18 inches above grade.
 - a. Treat lumber in other locations as indicated.
- E. Preservative Pressure Treatment of Plywood Above Grade: AWP A U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.
 1. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 2. Treat plywood in contact with masonry or concrete.
 3. Treat plywood less than 18 inches above grade.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking and similar supports to comply with requirements for attaching other construction.
- B. Do not use materials with defects that impair quality of rough carpentry or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- C. Select material sizes to minimize waste.
- D. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- E. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.3 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to code authorities may be used in lieu of solid wood blocking.
- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items,

unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- F. Specifically, provide the following non-structural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Towel and bath accessories.
 - 3. Wall-mounted door stops.
 - 4. Wall paneling and trim.

3.4 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size and Location: As indicated on drawings.

3.5 SITE APPLIED WOOD TREATMENT

- A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.
- B. Allow preservative to dry prior to erecting members.

3.6 TOLERANCES

- A. Framing Members: 1/4 inch from true position, maximum.
- B. Surface Flatness of Floor: 1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
- C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.

END OF SECTION

SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Finish carpentry items.
- B. Wood moldings.

1.2 RELATED REQUIREMENTS

- A. Section 064100 - Architectural Wood Casework: Shop fabricated custom cabinet work.
- B. Section 088000 - Glazing: Glass and glazing of wood partitions and screens.
- C. Section 099000 - Painting and Coating: Painting and finishing of finish carpentry items.

1.3 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2009.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
- D. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.
- E. PS 1 - Structural Plywood; 2007.
- F. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.
- G. WI (MAN) - Manual of Millwork; Woodwork Institute; 2003.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on fire retardant treatment materials and application instructions.
 - 2. Provide instructions for attachment hardware and finish hardware.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, to a minimum scale of 1-1/2 inch to 1 ft.
- D. Samples: Submit five samples of finish plywood, 12 inches in length illustrating wood grain and specified finish.
- E. Samples: Submit five samples of wood trim 12 inches long.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with AWI Architectural Woodwork Quality Standards Illustrated, Premium grade.
- B. Fabricator Qualifications: Company specializing in fabricating the products specified in this

section with minimum five years of documented experience.

- C. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum three years of documented experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire retardant requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect work from moisture damage.

1.8 PROJECT CONDITIONS

- A. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.
- B. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

PART 2 - PRODUCTS

2.1 FINISH CARPENTRY ITEMS

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI/AWMAC/WI Architectural Woodwork Standards for Premium Grade.
- B. Interior Woodwork Items:
 - 1. Moldings, Bases, Casings, and Miscellaneous Trim: Clear white pine; prepare for paint finish.
 - 2. Loose Shelving: Birch plywood; prepare for paint finish.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
- B. Provide sustainably harvested wood, certified or labeled as specified in Section 016000.
- C. Provide wood harvested within a 500 mile radius of the project site.

2.3 LUMBER MATERIALS

- A. Softwood Lumber: southern pine species, quarter sawn, maximum moisture content of 6 percent; with vertical grain, of quality suitable for transparent finish.
- B. Hardwood Lumber: white oak species, plain sliced, maximum moisture content of 6 percent, of quality suitable for transparent finish.

2.4 SHEET MATERIALS

- A. Softwood Plywood: PS 1 Grade A-B; Veneer core; birch face species, rotary cut.
- B. Particleboard: ANSI A208.1; composed of wood chips, sawdust, or flakes of medium density, made with waterproof resin binders; of grade to suit application; sanded faces.

2.5 FASTENINGS

- A. Fasteners: Of size and type to suit application; finishing nails in concealed locations and blind

nailing finish in exposed locations.

2.6 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. Shop prepare and identify components for book match grain matching during site erection.
- C. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

2.7 FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler that matches surrounding surfaces and is of type recommended for the applicable finish.
- D. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5 - Finishing for Grade specified and as follows:
 - 1. Opaque:
 - a. Color: As selected by Architect.
 - b. Sheen: Semigloss.
- E. Back prime woodwork items to be field finished, prior to installation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.2 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.
- D. Install hardware supplied by Section 08711 - Hardware in accordance with manufacturer's instructions.

3.3 PREPARATION FOR SITE FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Site Finishing: See Section 099000.
- C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.4 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION

SECTION 064100 - ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Cabinet hardware.
- C. Preparation for installing utilities.

1.2 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 123600 - Countertops.
- C. Section 099000 - Painting and Coating: Site finishing of cabinet exterior.

1.3 REFERENCE STANDARDS

- A. ANSI A135.4 - American National Standard for Basic Hardboard; 2004.
- B. ANSI A208.1 - American National Standard for Particleboard; 2009.
- C. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use; 2009.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
- E. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.
- F. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2010 (ANSI/BHMA A156.9).
- G. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2004 (ANSI/HPVA HP-1).
- H. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.
- I. NHLA G-101 - Rules for the Measurement & Inspection of Hardwood & Cypress; National Hardwood Lumber Association; 2007.
- J. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.
- K. WI (MAN) - Manual of Millwork; Woodwork Institute; 2003.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.

- B. Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location and schedule of finishes.
- C. Product Data: Provide data for hardware accessories, including cabinet hardware and accessories and finishing materials and processes. For hardboard, medium density fiberboard, particleboard, plywood, high pressure decorative laminate, adhesive for bonding plastic laminate, thermoset decorative overlay, solid surfacing material. cabinet hardware and accessories, and finishing materials and processes.
- D. Samples: Submit five actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.
- E. Samples: Submit five actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.
- F. Product Certificates: Signed by manufacturers of woodwork certifying that products furnished comply with requirements.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
- B. Perform work in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Custom quality, unless other quality is indicated for specific items.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- D. Manufacturer Qualifications: Member in good standing of the Architectural Woodwork Institute (AWI) and familiar with the AWI/AWMAC QSI.
- E. Quality Certification: Provide inspection and quality certification of completed custom cabinets in accordance with AWI/AWMAC Quality Certification Program.
- F. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production and installation of interior architectural woodworking including wood doors when veneer matching includes door faces.

1.6 MOCK-UP

- A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.7 PRE-INSTALLATION MEETING

- A. Convene not less than one week before starting work of this section.

1.8 COORDINATION

- A. coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on shop drawings.
 - 2. Established Dimensions: Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 CABINETS

- A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI Architectural Woodwork Standards for Custom Grade.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.
- B. Provide sustainably harvested wood, certified or labeled as specified in Section 016000.
- C. Provide wood harvested within a 500 mile radius of the project site.

2.3 LUMBER MATERIALS

- A. Softwood Lumber: NIST PS 20; Graded in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Grade II/Custom; average moisture content of 5-10 percent; species as scheduled.
- B. Hardwood Lumber: NHLA; Graded in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Grade II/Custom; average moisture content of 5-10 percent; species as scheduled.

2.4 PANEL MATERIALS

- A. Veneer Faced Plywood Finish: HPVA HP-1; graded in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, core of particleboard or medium density fiberboard; type of glue recommended for specific application; thickness as required; face veneer as follows:
 - 1. Exposed Surfaces: Grade AA, Birch, plain sliced, book-matched.
 - 2. Semi-Exposed Surfaces: Grade A, Birch, plain sliced, book-matched.
 - 3. Concealed Surfaces: Grade B, Birch, plain sliced, book-matched.
- B. Particleboard: ANSI A208.1; medium density industrial type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, composed of wood chips bonded with interior grade adhesive under heat and pressure; sanded faces; thickness as required; use for components indicated on drawings.
- C. Medium Density Fiberboard (MDF): ANSI A208.2; type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated; composed of wood fibers pressure bonded with moisture resistant adhesive to suit application; sanded faces; thickness as required.
 - 1. Use for components indicated on the drawings.
 - 2. Use as backing for plastic laminate unless otherwise indicated.
- D. Hardboard: AHA A135.4; Pressed wood fiber with resin binder, Class 1 - Tempered, 1/4 inch thick, smooth two sides (S2S); use for drawer bottoms, dust panels, and other components indicated on drawings.
- E. Hardwood Edgebanding: Use solid hardwood edgebanding matching species, color, grain, and grade for exposed portions of cabinetry.

2.5 LAMINATE MATERIALS

- A. Basis of Design Manufacturers:
 - 1. Abet Laminati: www.abetlaminati.com.
 - 2. Lamin-Art: www.laminart.com.
- B. Other Acceptable Manufacturers:
 - 1. Formica CorporationNone - N/A: www.formica.com.
 - 2. Panolam Industries International, Inc\Nevamar: www.nevamar.com.
 - 3. Wilsonart International, Inc: www.wilsonart.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- C. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications and as follows:
 - 1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
 - 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as scheduled, finish as scheduled.

3. Flame Retardant Surfaces: HGF, 0.048 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
4. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as scheduled, finish as scheduled.
5. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.6 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel, or chrome-plated finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.
- E. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.7 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using shelf brackets and coordinated shelf rests, satin chrome finish, for nominal 1 inch spacing adjustments. Comply with BHMA A156.9, B04102, with shelf brackets B04112.
- C. Adjustable Shelf Supports: Standard back-mounted system using surface mounted metal shelf standards and coordinated cantilevered shelf brackets, satin chrome finish, for nominal 1 inch spacing adjustments.
- D. Drawer and Door Pulls: "U" shaped wire pull, steel with satin finish, 4 inch centers.
- E. Sliding Door Pulls: Circular shape for recessed installation, steel with satin finish.
- F. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with satin finish. Comply with BMA A156.11, E07121.
- G. Drawer locks: Comply with BHMA A156.11, E07041
- H. Grommets for Cable Passage through Countertops: 2 inch OD, black, molded plastic grommets and matching plastic caps with slot for wire passage.
- I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 1. Dark, Anodized, Satin Bronze, Oil Rubbed: BHMA 613 for bronze base; BHMA 640 for steel base; match Architect's sample.

- J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- K. Catches: Magnetic.
- L. Drawer Slides:
 - 1. Type: Standard extension.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
 - 6. Products:
 - a. Accuride International, Inc: www.accuride.com.
 - b. Grass America Inc: www.grassusa.com.
 - c. Knape & Vogt Manufacturing Company: www.knapeandvogt.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- M. Hinges: European style concealed self-closing type, BHMA No. A156.9, B01602, steel with polished finish.
 - 1. Products:
 - a. Grass America Inc: www.grassusa.com.
 - b. Hardware Resources: www.hardwareresources.com.
 - c. Julius Blum, Inc: www.blum.com.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.8 SHOP TREATMENT OF WOOD MATERIALS

- A. Provide UL approved identification on fire retardant treated material.
- B. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.9 FABRICATION

- A. Cabinet Style: Flush overlay.
- B. Cabinet Doors and Drawer Fronts: Flush style.
- C. Drawer Construction Technique: Dovetail joints.
- D. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- E. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- F. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- G. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

- H. Mechanically fasten back splash to countertops with steel brackets at 16 inches on center.
- I. Provide cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and fixtures and fittings. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- B. Use fixture attachments in concealed locations for wall mounted components.
- C. Use concealed joint fasteners to align and secure adjoining cabinet units and countertops.
- D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
- E. Secure cabinets to floor using appropriate angles and anchorages. Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware so center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8" in 96 inch sag, bow or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, bear top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer head screws sized for 1 inch penetration into wood framing, blocking or hanging strips.
- F. Securely anchor countertops by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Align adjacent solid surface material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches and clean entire surface.
 - 2. Install countertops with no more than 1/8 inch in 96 inch sag, bow or other variation from a straight line.
 - 3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
 - 4. Caulk space between backsplash and wall with sealant.
- G. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.3 ADJUSTING

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Adjust installed work.
- C. Adjust moving or operating parts to function smoothly and correctly.
- D. Clean woodwork on exposed and semi exposed surfaces. Touch up shop applied finishes to restore damaged or soiled areas.

3.4 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 078400 - FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Firestopping systems.

1.2 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.3 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2011.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2011a.
- C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- D. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.
- E. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.
- G. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Schedule of Smokestopping: List each type of penetration to be sealed, indicating location, construction of penetrated assembly, identification of penetration seal to be used and design number.
- D. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- E. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- G. Certificate from authority having jurisdiction indicating approval of materials used.
- H. Qualification statements for installing mechanics.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery of products to minimize storage time at site.
- B. Deliver products to project site in original unopened containers bearing the name of the manufacturer, product name, type, and testing agency's identification mark.
- C. Store products in accordance with manufacturer's instructions.

1.6 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the specified fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:
 - 2. With minimum 3 years documented experience installing work of this type.
 - 3. Able to show at least 5 satisfactorily completed projects of comparable size and type.
 - 4. Licensed by authority having jurisdiction.
 - 5. Approved by firestopping manufacturer.
- D. Installing Mechanic's Qualifications: Trained by firestopping manufacturer and able to provide evidence thereof.

1.7 MOCK-UP

- A. Install one firestopping assembly representative of each fire rating design required on project.
 - 1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
 - 2. Where firestopping is intended to fill a linear opening, install minimum of 1 linear ft.
- B. Obtain approval of authority having jurisdiction before proceeding.
- C. If accepted, mock-up will represent minimum standard for the Work.
- D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.8 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

1.9 SEQUENCING AND SCHEDULING

- A. Perform firestopping and smokestopping work after completion of work which penetrates fire and smoke barriers, but prior to covering up or eliminating access to the penetration. Coordinate with installers of such other work.

PART 2 - PRODUCTS

2.1 FIRESTOPPING SYSTEMS

- A. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or

- less: Any material meeting requirements.
1. Floors: UL Design No. C-AJ-1014, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-L-1003, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-L-1003, F Rating 1 hour.
 4. Other Interior Partitions: UL Design No. W-L-1003, F Rating 1 hour.
- B. Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.
1. Floors: UL Design No. C-AJ-2001, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-L-2002, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-L-2002, F Rating 1-1/2 hour.
 4. Other Interior Partitions: UL Design No. W-L-2002, F Rating 3/4 hour.
- C. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.
1. Floors: UL Design No. C-AJ-3071, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-L-3030, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-L-3030, T Rating 1 hour.
 4. Other Interior Partitions: UL Design No. W-L-3030, F Rating 1 hour.
- D. Firestopping at Cable Tray Penetrations: Any material meeting requirements.
1. Floors: UL Design No. C-AJ-8069, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-L-8002, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-L-8002, F Rating 1-1/2 hour.
 4. Other Interior Partitions: UL Design No. W-L-8002, F Rating 1 hour.
- E. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Caulk or putty.
1. Floors: UL Design No. C-AJ-3021, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-L-3028, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-L-3028, F Rating 1 hour.
 4. Other Interior Partitions: UL Design No. W-L-3028, F Rating 1 hour.
- F. Firestopping at Control Joints (without Penetrations): Any material meeting requirements.
1. Floors: UL Design No. C-AJ-0012, F Rating 2 hour.
 2. Stairway Walls: UL Design No. W-J-003, F Rating 2 hour.
 3. Corridor Walls: UL Design No. W-J-003, F Rating 1 hour.
 4. Other Interior Partitions: UL Design No. W-J-003, F Rating 1 hour.
- G. Firestopping Between Edge of Floor Slab and Curtain Wall (without Penetrations): Glass fiber or mineral fiber safing insulation; UL Design No. CW-S-2001, F Rating 2 hour.

2.2 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant; conforming to the following:
1. Density: 1.35 g/cu.m.
 2. Tensile Strength: 270 as per ASTM D 412.
 3. Durability and Longevity: Permanent.
 4. Color: Black, dark gray, or red.
 5. Manufacturers:
 - a. A/D Fire Protection Systems Inc; Product A/D Fire Barrier: www.adfire.com.
 - b. 3M Fire Protection Products; Product 2000+ Silicone Sealant: www.3m.com/firestop.
 - c. Hilti, Inc; Product CP 604: www.us.hilti.com.
 - d. Specified Technologies, Inc; Product Pensil PEN300: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.

- C. Foam Firestopping: Multiple component silicone foam compound; conforming to the following:
1. Elongation: 600 percent.
 2. Density: 14-18 lb/cu ft.
 3. Durability and Longevity: Permanent.
 4. Color: Black.
 5. Manufacturers:
 - a. 3M Fire Protection Products; Product Fire Barrier 2001 Silicone RTV Foam: www.3m.com/firestop.
 - b. Hilti, Inc; Product CP 620: www.us.hilti.com.
 - c. Specified Technologies, Inc; Product PEN 200 Silicone Foam: www.stifirestop.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers; conforming to the following:
1. Density: 4 lb/cu ft.
 2. Durability and Longevity: Permanent.
 3. Color: Manufacturer's standard color.
 4. Manufacturers:
 - a. A/D Fire Protection Systems Inc; Product A/D Fire Barrier Mineral Wool: www.adfire.com.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening; conforming to the following:
1. Density: 4.0 lb/cu ft.
 2. Durability and Longevity: Permanent.
 3. Manufacturers:
 - a. A/D Fire Protection Systems Inc; Product Fire Barrier Seal w/ Fire Barrier Mineral Wool joint backing: www.adfire.com.
 - b. Pecora Corporation; Product Dynatrol Sealant w/ Ultra Block joint backing: www.pecora.com.
 - c. Substitutions: See Section 016000 - Product Requirements.
- F. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and collar and flanged stops, intended to be installed after penetrating item has been installed; conforming to the following:
1. Durability and Longevity: Permanent.
 2. Manufacturers:
 - a. Grace Construction Products; Product Flamesafe FireStop Device (FSD): www.na.graceconstruction.com.
 - b. 3M Fire Protection Products; Product Fire Barrier Plastic Pipe Devices: www.3m.com/firestop.
 - c. Hilti, Inc; Product CP 643N: www.us.hilti.com.
 - d. Specified Technologies, Inc; Product Firestop Collars: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- G. Firestop Devices - Cast-In Type: Sleeve and sealing material, intended to be cast in concrete floor forms or in concrete on metal deck, not requiring any additional materials to achieve penetration seal.
1. Durability and Longevity: Permanent.
 2. Manufacturers:
 - a. 3M Fire Protection Products; Product Fire Barrier Cast-in-Device: www.3m.com/firestop.
 - b. Hilti, Inc; Product CP 680: www.us.hilti.com.
 - c. Substitutions: See Section 016000 - Product Requirements.

the following:

1. Potential Expansion: Minimum 500 percent.
 2. Density: 1.45 lb/cu ft.
 3. Durability and Longevity: Permanent.
 4. Color: Black, dark gray, or red.
 5. Manufacturers:
 - a. Grace Construction Products; Product FSP 1000: www.na.graceconstruction.com.
 - b. 3M Fire Protection Products; Product Fire Barrier Moldable Putty: www.3m.com/firestop.
 - c. Hilti, Inc; Product CP 618: www.us.hilti.com.
 - d. Specified Technologies, Inc; Product SSP Putty: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- I. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration; conforming to the following:
1. Density: 4.0 lb/cu ft.
 2. Durability and Longevity: Permanent.
 3. Manufacturers:
 - a. Grace Construction Products; Product FlameSafe Pillows: www.na.graceconstruction.com.
 - b. Hilti, Inc; Product FS 657 Fire Block: www.us.hilti.com.
 - c. Nelson FireStop Products; Product PLW Firestop Pillows: www.nelsonfirestop.com.
 - d. Specified Technologies, Inc; Product SpecSeal Firestop Pillows: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- J. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, openings, voids, adjoining construction and conditions under which the Work is to be installed. Confirm compatibility of surfaces scheduled to receive fireproofing.
- B. Verify openings are ready to receive the work of this section.
 1. Conduct inspection prior to covering up or enclosing walls or ceilings.
 2. Submit a report detailing findings of this inspection to the Architect.
- C. Verify that penetrating elements are securely fixed and properly located with the proper space allowance between penetrations and surfaces of openings.
- D. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Prime substrates in accordance with manufacturer's written instructions or recommendations. Confine primers to areas of bond; do not allow spillage or migration onto exposed surfaces.
- D. Install backing materials to arrest liquid material leakage.
- E. Ensure that anchoring devices, back-up materials, clips sleeves, supports and other related

materials used in the actual fire tests are provided.

- F. Installation is not to proceed until submittals have been completed.

3.3 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Remove combustible forming materials, unless they are a required component of the tested assembly.
- D. Install labelling required by code.

3.4 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.5 PERMANENT IDENTIFICATION OF PENETRATIONS

- A. Near fire and smoke barriers, mark each exposed penetration with label identifying it as a fire-stopped or smoke-stopped assembly.
- B. Mark each fire and smoke barrier above lay-in ceilings with words identifying it as a fire or smoke barrier at intervals required by authorities having jurisdiction.

3.6 FIELD QUALITY CONTROL

- A. Inspect completed installations for completeness and correct installation.
- B. If installed work is to be covered in completed work, inspect and obtain approval prior to covering.
- C. Obtain the approval of the authority having jurisdiction.
- D. Submit the report of the inspection to the Architect.

3.7 PROTECTION

- A. Clean adjacent surfaces of firestopping materials. Use methods and materials approved by the manufacturer of the penetration seals and of surfaces to be cleaned.
- B. Protect adjacent surfaces from damage by material installation.
- C. Protect installed work during the curing period
- D. Repair damaged materials in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 079005 - JOINT SEALERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sealants and joint backing.
- B. Hollow gaskets.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping: Firestopping sealants.
- B. Section 088000 - Glazing: Glazing sealants and accessories.
- C. Section 092116 - Gypsum Board Assemblies: Acoustic sealant.

1.3 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2010.
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2008.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2010.
- E. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Poly(Vinyl Chloride) Foam (Closed-Cell); 2005 (Reapproved 2011).
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.4 DEFINITIONS

- A. Substrates:
 - 1. G Type Substrates: Glass and transparent plastic glazing sheets.
 - 2. A Type Substrates: Metal, porcelain, glazed tile and smooth plastics.
 - 3. O Type Substrates: Wood, Unglazed tile; substrates not included under other categories.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics, with instructions for substrate preparation and installation.
- C. Samples: Submit five samples, illustrating sealant colors for selection.
- D. Substrate Test Report for each sealer.
- E. Certificates: For each sealant, provide manufacturer's certificate stating that the product complies with the specifications and is appropriate for the use it is being put to.
- F. Manufacturer's Installation Instructions: Indicate special procedures.

1.6 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.

- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- C. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years experience.

1.7 MOCK-UP

- A. Provide mock-up of sealant joints in conjunction with window under provisions of Section 014000.
- B. Construct mock-up with specified sealant types and with other components noted.
- C. Locate where directed.
- D. Mock-up may not remain as part of the Work.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in original containers or bundles with labels showing manufacturer, product name or designation, color, shelf life and installation instructions.

1.9 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.10 COORDINATION

- A. Coordinate the work with all sections referencing this section.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a five year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Silicone Sealants:
 - 1. Bostik Inc; Product ChemCalk 1200: www.bostik-us.com.
 - 2. Pecora Corporation; Product 895: www.pecora.com.
 - 3. BASF Construction Chemicals-Building Systems; Product Sonolastic 150: www.buildingsystems.basf.com.

- B. Polyurethane Sealants:
 - 1. Bostik Inc; Product Chem-Calk 900: www.bostik-us.com.
 - 2. Pecora Corporation; Product Dynatrol I XL: www.pecora.com.
 - 3. BASF Construction Chemicals-Building Systems; Product Sonolastic NP 1: www.buildingsystems.basf.com.
- C. Acrylic Sealants (ASTM C920):
 - 1. Tremco Global Sealants; Product TremFlex 834: www.tremcosealants.com.
- D. Butyl Sealants:
 - 1. Bostik Inc; Product Chem-Calk 300: www.bostik-us.com.
 - 2. Pecora Corporation; Product BC-158: www.pecora.com.
 - 3. Substitutions: See Section 016000 - Product Requirements.
- E. Acrylic Emulsion Latex Sealants:
 - 1. Bostik Inc; Product Chem-Calk 600: www.bostik-us.com.
 - 2. Pecora Corporation; Product AC-20: www.pecora.com.
 - 3. BASF Construction Chemicals-Building Systems; Product Sonolac: www.buildingsystems.basf.com.
- F. Preformed Compressible Foam Sealers:
 - 1. EMSEAL Joint Systems, Ltd; Product Backerseal (Greyflex): www.emseal.com.
 - 2. Sandell Manufacturing Company, Inc; Product Polyseal: www.sandellmfg.com.

2.2 SEALANTS

- A. Sealants and Primers - General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NS single component, paintable.
 - 1. Color: Colors as selected.
 - 2. Applications: Use for:
 - a. Interior wall and ceiling control joints.
 - b. Joints between door and window frames and wall surfaces.
 - c. Other interior joints for which no other type of sealant is indicated.
- C. Bathtub/Tile Sealant: White silicone; ASTM C920, Uses I, M and A; single component, mildew resistant.
 - 1. Applications: Use for:
 - a. Joints between plumbing fixtures and floor and wall surfaces.
 - b. Joints between kitchen and bath countertops and wall surfaces.
- D. Acoustical Sealant for Concealed Locations: Permanently tacky non-hardening butyl sealant.
 - 1. Applications: Use for concealed locations only:
 - a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

- E. Nonsag Polyurethane Sealant: ASTM C920, Grade NS, Class 25, Uses NT, I, M, A, G, O; single component, chemical curing, non-staining, non bleeding, capable of continuous water immersion, non-sagging type.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Movement Capability: Plus and minus 25 percent.
 - 3. Service Temperature Range: -40 to 180 degrees F.
 - 4. Shore A Hardness Range: 20 to 35.
- F. Silicone Sealant: ASTM C920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, solvent curing, non-sagging, non-staining, fungus resistant, non-bleeding.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Movement Capability: Plus and minus 25 percent.
 - 3. Service Temperature Range: -65 to 180 degrees F.
 - 4. Shore A Hardness Range: 15 to 35.

2.3 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean and prime joints in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Protect elements surrounding the work of this section from damage or disfigurement.

3.3 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C 1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

- E. Install bond breaker where joint backing is not used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Tool joints concave.

3.4 CLEANING

- A. Clean adjacent soiled surfaces.

3.5 PROTECTION

- A. Protect sealants until cured.
- B. Remove and replace damaged sealers.

END OF SECTION

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Non-fire-rated steel frames.
- B. Fire-rated steel door frames.
- C. Frames for sound-rated doors.
- D. Interior glazed light frames.

1.2 RELATED REQUIREMENTS

- A. Section 087111 - Door Hardware: Hardware and weatherstripping.
- B. Section 088000 - Glazing: Glass for borrowed lites.
- C. Section 099000 - Painting and Coating: Field painting.

1.3 REFERENCE STANDARDS

- A. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council; 2003.
- B. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2003.
- C. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998 (R2004).
- D. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.
- E. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute; 2000 (ANSI/DHI A115 Series).
- F. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.
- G. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2010.
- H. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- I. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- J. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- C. Samples: Submit five samples of frame metal, 2 x 2 inches in size showing factory finishes,

colors, and surface textures.

- D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- E. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- B. Obtain hollow metal work from single manufacturer.
- C. Maintain at the project site a copy of all reference standards dealing with installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.
- C. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors. Deliver such items to project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Steel Frames:
 - 1. Assa Abloy Ceko, Curries, or Fleming: www.assaabloydss.com.
 - 2. Windsor Republic Doors: www.republicdoor.com.
 - 3. Steelcraft: www.steelcraft.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Cold Rolled Sheet Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) metallic coating.
- C. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

- D. Inserts, Bolts and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- E. Power Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips of other accessory devices for attaching hollow metal frames of type indicated.
- F. Mineral Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12 lb/cu.ft. density; with maximum flame spread and smoke development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 08 80 00 - Glazing.
- H. Bituminous Coating: Cold applied asphalt mastic, SSPC-Paint 12, compounded for 15 mil dry film thickness per coat. Provide inert type noncorrosive compound free from asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STEEL DOOR FRAMES

- A. Requirements for All Frames:
 - 1. Accessibility: Comply with ANSI/ICC A117.1.
 - 2. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
 - 3. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
 - 4. Finish: Factory primed, for field finishing.
 - 5. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.
 - 6. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
 - 7. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
 - 8. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into frame head, flush with top.
 - 9. Frames Installed Back-to-Back: Reinforce with steel channels anchored to floor and overhead structure.
- B. Interior Door Frames, Non-Fire-Rated: Face welded type.
 - 1. Grade: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gage
 - 2. Terminated Stops: Provide at all interior doors; closed end stop terminated 6 inches above floor at 45 degree angle.
- C. Interior Door Frames, Fire-Rated: Face welded type.
 - 1. Grade: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gage
 - 2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
 - a. Provide units listed and labeled by UL.
 - b. Attach fire rating label to each fire rated unit.
 - 3. Smoke and Draft Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures; with "S" label; if necessary, provide additional gasketing or edge sealing.

- D. Sound-Rated Door Frames: Knock-down type.
 - 1. Grade: Comply with frame requirements specified in ANSI A250.8 for Level 1, 16 gage
 - 2. Sound Rating: Tested with the door to achieve the rating specified for the door opening.
- E. Mullions for Pairs of Doors: Fixed, except where removable is indicated, of profile similar to jambs.
- F. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.4 ACCESSORY MATERIALS

- A. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- B. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- C. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.
- D. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames used for shipping purpose only.

2.5 FINISH MATERIALS

- A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.
- B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
- B. Examine rough-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Verify that opening sizes and tolerances are acceptable.
- D. Prepare written report, endorsed by the Installer, listing conditions detrimental to performance of the work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling and dressing as required to make area smooth, flush and invisible on exposed faces.
- B. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.
- C. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16", measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16" measured at jambs on a horizontal line parallel to plane of

- wall.
 - 3. Twist: Plus or minus 1/16" measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16" measured at jambs on a perpendicular line from head to floor.
- D. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch.

3.3 INSTALLATION

- A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
- B. In addition, install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
 - 1. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post installed expansion anchors.
 - a. Floor anchors may be set with power actuated fasteners instead of post installed expansion anchors if so indicated and approved on shop drawings.
 - 2. Metal Stud Partitions: Solidly pack mineral fiber insulation behind frames.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 4. In-Place Concrete or Masonry Construction: Secure frames in place with post installed expansion anchors. Countersink anchors, and fill and make smooth, flush and invisible on exposed faces.
 - 5. In-Place Gypsum Board Partitions: Secure frames in place with post installed expansion anchors through floor anchors at each jamb. Countersink anchors and fill and make smooth, flush and invisible on exposed faces.
 - 6. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural supports at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

- 7. Installation Tolerances: Adjust hollow metal frames for squareness, alignment, twist and plumbness.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Coordinate installation of glazing.
- F. Coordinate installation of hardware.
- G. Coordinate installation of electrical connections to electrical hardware items.
- H. Touch up damaged factory finishes.

3.4 TOLERANCES

- A. Clearances Between Door and Frame: As specified in ANSI A250.8.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edges, crossed corner to corner.

3.5 ADJUSTING AND CLEANING

- A. Remove grout and other bonding material from hollow metal work immediately after installation.
- B. Prime Coat Touch-up: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touch-up of compatible air-drying, rust inhibitive primer.

END OF SECTION

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flush wood doors; flush configuration; fire rated, non-rated, and acoustical.

1.2 RELATED REQUIREMENTS

- A. Section 081213 - Hollow Metal Frames.
- B. Section 087111 - Door Hardware.
- C. Section 088000 - Glazing.
- D. Section 099000 - Painting and Coating: Site finishing of doors.

1.3 REFERENCE STANDARDS

- A. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- B. ASTM E1408 - Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems; 1991 (Reapproved 2000).
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2009.
- D. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.
- E. ICC (IBC) - International Building Code; 2009.
- F. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.
- G. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2010.
- H. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.
- I. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
 - 1. Provide the information required by AWI/AWMAC/WI Architectural Woodwork Standards.
 - 2. Include certification program label.
- C. Specimen warranty.
- D. Test Reports: Show compliance with specified requirements for the following:
 - 1. Sound-retardant doors and frames; sealed panel tests are not acceptable.
- E. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria, identify cutouts for glazing.

- F. Samples: Submit five samples of door construction, 8x10 inch in size cut from top corner of door.
- G. Samples: Submit five samples of door veneer, 8x10 inch in size illustrating wood grain.
- H. Manufacturer's Installation Instructions: Indicate special installation instructions.
- I. Warranty, executed in Owner's name.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of the specified door quality standard on site for review during installation and finishing.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- C. Obtain flush wood doors from single manufacturer.
- D. Provide WI-Certified Compliance Certificate indicating that doors comply with requirements of grades specified.
- E. Provide WI-Certified Compliance Certificate for installation.
- F. Installed Fire Rated Door Assembly: Conform to NFPA 80 for fire rated class as indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.7 PROJECT CONDITIONS

- A. Coordinate the work with door opening construction, door frame and door hardware installation.
- B. Do not deliver or install doors until spaces are enclosed and weathertight wet work is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Graham Wood Doors: www.grahamdoors.com.
 - 2. Eggers Industries: www.eggersindustries.com.
 - 3. Haley Brothers: www.haleybros.com.
 - 4. Marshfield DoorSystems, Inc: www.marshfielddoors.com.

5. Substitutions: See Section 016000 - Product Requirements.

2.2 DOORS AND PANELS

- A. All Doors: See drawings for locations and additional requirements.
 - 1. Quality Level: Custom Grade, in accordance with AWI/AWMAC/WI Architectural Woodwork Standards.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at all locations.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with International Building Code ("positive pressure"); UL or WH (ITS) labeled without any visible seals when door is open.
 - 3. Smoke and Draft Control Doors: In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft of door opening at 0.10 inch w.g. pressure at both ambient and elevated temperatures; with "S" label; if necessary, provide additional gasketing or edge sealing.
 - 4. Sound Retardant Doors: Minimum STC of 41, calculated in accordance with ASTM E413, tested in accordance with ASTM E1408.

2.3 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated above.
- B. Fire Rated Doors: Mineral core, Type FD, plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C. Sound Retardant Doors: Equivalent to Type PC construction with core as required to achieve rating specified; plies and faces as indicated above.

2.4 DOOR FACINGS

- A. Veneer Facing for Opaque Finish: Close grain hardwood.

2.5 ACCESSORIES

- A. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- B. Astragals for Non-Rated Double Doors: Steel, T shaped, overlapping and recessed at face edge.
- C. Astragals for Fire Rated Double Doors: Steel, T shaped, overlapping and recessed at face edge, specifically for double doors.

2.6 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 - 1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
 - 2. Provide solid blocking for other throughbolted hardware.
- C. Fit door edge trim to edge of stiles after applying veneer facing.
- D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.

- E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
 - 1. Exception: Doors to be field finished.
- F. Provide edge clearances in accordance with the quality standard specified.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Field-Finished Doors: Trimming to fit is acceptable.
 - 1. Adjust width of non-rated doors by cutting equally on both jamb edges.
 - 2. Trim maximum of 3/4 inch off bottom edges.
 - 3. Trim fire-rated doors in strict compliance with fire rating limitations.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.
- F. Install door louvers plumb and level.

3.3 TOLERANCES

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.
- C. Maximum Vertical Distortion (Bow): 1/8 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 by 84 inches surface area.
- D. Maximum Width Distortion (Cup): 1/8 inch measured with straight edge or taut string, edge to edge, over an imaginary 36 by 84 inches surface area.

3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.
- C. Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

SECTION 081433 - STILE AND RAIL WOOD DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wood doors, stile and rail design.
- B. Panels of wood and glass.

1.2 RELATED REQUIREMENTS

- A. Section 081213 - Hollow Metal Frames.
- B. Section 087111 - Door Hardware.
- C. Section 088000 - Glazing.
- D. Section 099000 – Interior Painting.

1.3 REFERENCE STANDARDS

- A. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate stile and rail core materials and construction; veneer species, type and characteristics.
- C. Specimen warranty.
- D. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, factory finishing criteria.
- E. Samples: Submit five samples of door construction, 8x10 inch in size cut from top corner of door.
- F. Manufacturer's Installation Instructions: Indicate special installation instructions.
- G. Warranty, executed in Owner's name.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1400, Custom grade.
- B. Factory finish doors in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1500.
- C. Obtain stile and rail wood doors from a single manufacturer.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1300.
- B. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.7 PROJECT CONDITIONS

- A. Coordinate the work with door opening construction, door frame and door hardware installation.
- B. Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Include coverage for warping beyond specified installation tolerances and defective materials.
- C. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
- D. Warranty shall be in effect during the following period of time from the Date of Substantial Completion:
 - 1. Interior Doors: Five years.
 - 2. Glass Vision Panels: Three years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Stile and Rail Wood Doors:
 - 1. Eggers Industries: www.eggersindustries.com.
 - 2. Maiman Company: www.maiman.com.
 - 3. Marshfield Door Systems, Inc.: www.marshfielddoors.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 DOORS

- A. Quality Level: Custom Grade, in accordance with AWI/AWMAC/WI Architectural Woodwork Standards.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; solid lumber construction; mortised and tenoned joints.
- C. Glass: Uncoated, clear, fully tempered float glass, 6.0 mm thick complying with Section 088000 - Glazing.

2.3 DOOR FACINGS

- A. Interior Doors: Wood veneer, see drawings for wood species, quarter sliced, with random matched grain, for opaque finish.
- B. Adhesive: Type I - waterproof.

2.4 DOOR CONSTRUCTION

- A. Fabricate in accordance with AWI/AWMAC Quality Standards Illustrated, Section 1400, Custom grade.
 - 1. Door Construction for Opaque Finish:
 - a. Stile and Rail Construction: Clear softwood; may be edge glued for width and finger jointed.
 - b. Flat-Panel Construction: Veneered, wood-based panel product.
 - 2. Stile and Rail Widths: Manufacturer's standard, but not less than the following:
 - a. Stiles, Top and Intermediate Rails: 4-1/2 inches.
 - b. Bottom Rails: 9 inches.

- B. Fit door edge trim to edge of stiles after applying veneer facing.
- C. Bond edge banding to cores.
- D. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware.
- E. Factory fit doors for frame opening dimensions identified on shop drawings.
- F. Glazed Openings: Glaze doors at factory with glass of type and thickness indicated, complying with Division 08 Section "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C 920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.

2.5 FACTORY FINISHING

- A. Finish wood doors at factory where indicated in schedules or on Drawings. Wood doors that are not indicated to be factory finished may be field finished.
- B. Shop Priming: Shop prime doors with one coat of wood primer specified in Division 09 Section Painting. Seal all four edges, edges of cutouts, and mortises with primer.
- B. Opaque Finish:
 - 1. Grade: Custom.
 - 2. Color: As selected by Architect from manufacturer's full range.
 - 3. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out of tolerance for size or alignment.

3.2 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and AWI/AWMAC Quality Standards requirements.
- B. Trim door width by cutting equally on both jamb edges.
- C. Trim door height by cutting bottom edges to a maximum of 3/4 inch.
- D. Machine cut for hardware.
- E. Coordinate installation of doors with installation of frames and hardware.
- F. Coordinate installation of glazing.

3.3 TOLERANCES

- A. Conform to specified quality standard for fit, clearance, and joinery tolerances.
- B. Maximum Diagonal Distortion (Warp): 1/8 inch measured with straight edge or taut string, corner to corner, over an imaginary 36 x 84 inch surface area.
- C. Maximum Vertical Distortion (Bow): 1/8 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 x 84 inch surface area.
- D. Maximum Width Distortion (Cup): 1/8 inch measured with straight edge or taut string, edge to edge, over an imaginary 36 x 84 inch surface area.

3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.
- C. Replace doors that are damaged or do not comply with requirements.

END OF SECTION

SECTION 087111 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hinges
- B. Continuous Hinges
- C. Pivots
- D. Key control system
- E. Lock cylinders and keys
- F. Lock and latch sets
- G. Bolts
- H. Exit devices
- I. Push/Pull units
- J. Closers
- K. Overhead holders
- L. Miscellaneous door control devices
- M. Door trim units
- N. Protection plates
- O. Weather stripping for exterior doors
- P. Sound stripping for interior doors
- Q. Automatic drop seals (door bottoms)
- R. Astragals or meeting seals on pairs of doors
- S. Thresholds

1.2 RELATED REQUIREMENTS

- A. Section 081213 - Hollow Metal Frames.
- B. Section 081416 – Flush Wood Doors.
- C. Section 084250 – All-Glass Doors and Frames.
- D. Division 26: Electrical

1.3 REFERENCES

- A. Standards of the following as referenced:
 - 1. American National Standards Institute (ANSI)
 - 2. Door and Hardware Institute (DHI)
 - 3. Factory Mutual (FM)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters' Laboratories, Inc. (UL)
 - a. UL 10C - Fire Tests Door Assemblies
 - 6. Warnock Hersey

- B. Regulatory standards of the following as referenced:
 - 1. Department of Justice, Office of the Attorney General, Americans with Disabilities Act, Public Law 101-336 (ADA).
 - 2. CABO/ANSI A117.1: Providing Accessibility and Usability for Physically Handicap People, 1992 edition.

1.4 SYSTEM DESCRIPTION

- A. Refer to applicable Headings for system description for electric and electro-pneumatic hardware products.

1.5 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification sections.
- B. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- C. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into vertical format "hardware sets" indicating complete designations of every item required for each door or opening. Use specification Heading numbers with any variations suffixed a, b, etc. Include the following information:
 - a. Type, style, function, size, and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.
 - e. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for hardware.
 - g. Door and frame sizes and materials.
 - h. Keying information.
 - i. Cross-reference numbers used within schedule deviating from those specified.
 - 1) Column 1: State specified item and manufacturer.
 - 2) Column 2: State prior approved substituted item and its manufacturer.
 - 2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
 - 3. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.
- D. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- E. Contract closeout submittals:
 - 1. Operation and maintenance data: Complete information for installed door hardware.
 - 2. Warranty: Completed and executed warranty forms.

1.6 QUALITY CRITERIA

- A. Supplier Qualifications:

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1. The finish hardware supplier shall be a factory authorized distributor with office and warehouse facilities within a 100-mile radius of Atlanta, Georgia.
 2. The finish hardware supplier shall have a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project.
 3. The finish hardware supplier shall employ an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the work, for consultation.
- B. The hardware manufacturer's representative(s) shall conduct a pre-installation conference with the Contractor's installer, a representative of the county planning and/or maintenance department, and a representative of the hardware supplier, to demonstrate product installation and adjustment in accordance with manufacturer's recommendations and Owner's requirements.
- C. Hardware manufacturers' representative shall inspect hardware installation to confirm that all products are installed and adjusted according to manufacturer's recommendations. A certificate of compliance shall be submitted with the project closeout documents.

1.7 DELIVERY, STORAGE AND PROTECTION

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.8 WARRANTY

- A. Special warranties:
1. Door Closers: Ten year period
 2. Exit Devices: Three year period

1.9 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door-hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Hinges:
1. Acceptable Manufacturers:

- a. Hager Hinge Company
- b. Stanley Works
- c. McKinney
- 2. Characteristics:
 - a. Templates: Provide only template-produced units.
 - b. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1) For metal doors and frames install machine screws into drilled and tapped holes.
 - 2) For wood doors and frames install threaded-to-the-head wood screws.
 - 3) For fire-rated wood doors install #12 x 1-1/4 inch, threaded-to-the-head steel wood screws.
 - 4) Finish screw heads to match surface of hinges or pivots.
 - c. Hinge pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1) Out-Swing Exterior Doors: Non-removable pins.
 - 2) Out-Swing Corridor Doors with Locks: Non-removable pins.
 - 3) Interior Doors: Non-rising pins.
 - 4) Tips: Flat button and matching plug. Finished to match leaves.
 - 5) Size: Size hinges in accordance with specified manufacturer's published recommendations.
 - 6) Quantity: Furnish one pair of hinges for all doors up to 5'0" high. Furnish one hinge for each additional 2-1/2 feet or fraction thereof.
- B. Continuous Hinges:
 - 1. Acceptable Manufacturers:
 - a. Markar
 - b. Select Products
 - c. Zero
 - 2. Characteristics:
 - a. Continuous gear hinges to be manufactured of extruded 6063-T6 aluminum alloy with anodized finish, or factory painted finish as scheduled.
 - b. All hinges are to be manufactured to template. Uncut hinges shall be non-handed and shall be a pinless assembly of three interlocking extrusions applied to the full height of the door and frame without mortising.
 - c. Vertical door loads shall be carried on chemically lubricated polyacetal thrust bearings. The door and frame leaves shall be continually geared together for the entire hinge length and secured with a full cover channel. Hinge to operate to a full 180o.
 - d. Hinges to be milled, anodized and assembled in matching pairs. Fasteners supplied shall be 410 stainless steel, plated and hardened.
 - e. Provide UL listed continuous hinges at fire doors. Continuous hinges at fire doors (suffix -FR) shall meet the required ratings without the use of auxiliary fused pins or studs.
 - f. Provide continuous hinges at restroom doors.
- C. Pivot Sets:
 - 1. Acceptable Manufacturers:
 - a. Dor-O-Matic
 - b. Glynn Johnson
 - c. LCN, Division of Ingersoll-Rand
 - 2. Characteristics:
 - a. Pivots to be high strength forged bronze with top pivot housing with spring activated bronze retracting pin. Pivots to have tilt-on bearing and bearing pin.
 - b. Center hung pivots to support doors up to 300 pounds. Jamb portion of top center pivot to fit into a 1- 3/4" header.
- D. Cylinders:
 - 1. Acceptable Manufacturers:

- a. Best Access Systems
2. Characteristics:
 - a. Review the keying system with the Owner and provide the type required (master, grandmaster or great-grandmaster), either new or integrated with Owner's existing system.
 - b. Equip locks with cylinders for interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these when directed.
 - c. Furnish final cores and keys for installation by Owner.
 - d. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.
 - e. Comply with Owner's instructions for master-keying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation, "DO NOT DUPLICATE."
 - f. Key Material: Provide keys of nickel silver only.
 - g. Key Quantity: Furnish 3 change keys for each lock, 5 master keys for each master system, and 5 grandmaster keys for each grandmaster system. Deliver keys to Owner.
- E. Locksets, Latchsets, Deadbolts:
 1. Acceptable Manufacturers:
 - a. Best Access Systems 35H Series x 14H
 2. Mortise Locksets and Latch-sets: as scheduled.
 - a. Chassis: cold-rolled steel, handing field-changeable without disassembly.
 - b. Latch-bolts: 3/4-inch throw stainless steel anti-friction type.
 - c. Lever Trim: through-bolted, accessible design, cast or solid rod lever as scheduled. Spindles: independent break-away.
 - d. Thumb-turns: accessible design not requiring pinching or twisting motions to operate.
 - e. Deadbolts: stainless steel 1-inch throw.
 - f. Electric operation: Manufacturer-installed continuous-duty solenoid.
 - g. Strikes: 16 gage curved stainless steel, bronze or brass with 1" deep box construction, lips of sufficient length to clear trim and protect clothing.
 - h. Scheduled Lock Series and Design: Schlage L Series, 17A Design.
 - i. Certifications:
 - 1) ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
 - 2) ANSI/ASTM F476-84 Grade 30 UL Listed.
- F. Exit Devices:
 1. Acceptable Manufacturers:
 - a. Von Duprin, Division of Ingersoll-Rand, CD98/98 Series
 2. Characteristics:
 - a. Exit devices shall be "UL" listed for life safety. All exit devices for fire rated openings shall have "UL" labels for "Fire Exit Hardware."
 - b. All exit devices mounted on labeled wood doors shall be thru-bolted mounted on the door per the door manufacturers' requirements.
 - c. All trim shall be thru-bolted to the lock stile case.
 - d. All exit devices shall be made of brass, bronze, stainless steel, or aluminum material, plated, anodized, or powder coated to the standard architectural finishes to match the balance of the door hardware.
 - e. Provide glass bead conversion kits to shim exit devices on doors with raised glass heads.
 - f. All exit devices shall be one manufacturer. No deviation will be considered.
 - g. All series exit devices shall incorporate a fluid damper, which decelerates the

touchpad on its return stroke and eliminates noise associated with exit device operation. All exit devices shall be non-handed. Touchpad shall extend a minimum of 1/2 of the door width and shall be a minimum of 2-3/16" in height. Plastic touchpads are not acceptable. All latchbolts to be the deadlocking type. Latchbolts shall have a self-lubricating coating to reduce wear. Plated or plastic coated latchbolts are not acceptable. Plastic linkage and "dogging" components are not acceptable.

- h. Lever trim shall be solid case material with a break-away feature to limit damage to the unit from vandalism.
- i. Surface vertical rod devices shall be UL labeled for fire door (180 and 90 minute metal doors and 20 minute wood doors) applications without the use of bottom rod assemblies. Where bottom rods are required for security applications, the devices shall be UL labeled for fire doors applications with rod and latch guards by the device manufacturer.

G. Closers and Door Control Devices:

- 1. Acceptable Manufacturers:
 - a. LCN Closers, Division of Ingersoll-Rand 4011, 4111-EDA, 4111-CNS, 4111-S-CNS
- 2. Characteristics:
 - a. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder.
 - b. All closers shall utilize a stable fluid withstanding temperature range of 120oF to -30oF without seasonal adjustment of closer speed to properly close the door. Closers for fire-rated doors shall be provided with temperature stabilizing fluid that complies with standards UBC 7-2 (1997) and UL 10C.
 - c. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed and back check.
 - d. All closers shall have solid forged steel main arms (and forearms for parallel arm closers) and where specified shall have a spring loaded stop on the closer shoe ("Spring Cush"). Where door travel on out-swing doors must be limited, use "CNS or S-CNS" type closers. Auxiliary stops are not required when cushion type closers are used.
 - e. Over-head concealed closers shall have spring power adjustable for 50% increase in closing power and fully mortised door tracks.
 - f. All closers shall be certified to exceed ten million (10,000,000) full load cycles by a recognized independent testing laboratory. All closers (overhead, surface and concealed) shall be of one manufacturer and carry manufacturer's ten- year warranty (electric closers to have two year warranty).
 - g. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped, provide adjustable units complying with ADA and ANSI A-117.1 provisions for door opening force.
 - h. Closers to be installed to allow door swing as shown on plans. Doors swinging into exit corridors shall provide for corridor clear width as required by code. Where possible, mount closers inside rooms.
 - i. Powder coating finish to be certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.
 - j. Combination Door Closers and Holders: Provide units designed to hold door in open position under normal usage and to release and automatically close door under fire conditions. Incorporate an integral electromagnetic holder mechanism designed for use with UL listed fire detectors, provided with normally closed switching contacts. Where Combination Door Closers, Holder, and Detectors are scheduled, provide integral UL Listed photo-electric 24V detector module.
 - k. Closers shall be provided with fully deep drawn powder coated metal covers (no

seams).

H. Power Operators:

1. Where low kinetic energy, as defined by ANSI Standard A156.19, power operators are indicated for doors required to be accessible to the disabled, provide electrically powered 4620 Series operators complying with the 1990 ADA for opening force and time to close standards.
2. Full closing force shall be provided when the power or assist cycle ends.
3. All power operator systems shall include the following features and functions:
 - a. Provisions for separate conduits to carry high and low voltage wiring in compliance with the National Electrical Code, section 725-31.
 - b. When an obstruction or resistance to the opening swing is encountered, the operator will continue attempting to open the door. If the obstruction or resistance remains, the operator will again pause the door.
 - c. The operator will be designed to prevent damage to the mechanism if the system is actuated while the door is latched or if the door is forced closed during the opening cycle.
 - d. All covers, mounting plates and arm systems shall be powder coated and successfully pass a minimum of 100 hours testing as outlined in ANSI Standard A156.18.
 - e. UL listed for use on labeled doors.
 - f. All operators shall be non-handed with spring power over a range of at least four sizes; either 1 through 4 or 2 through 5.
 - g. Provisions in the control box or module shall provide control (inputs and outputs) for; electric strike delay, auxiliary contacts, sequential operation, fire alarms systems, actuators, swing side sensors, stop side sensors.
4. All electrically powered operators shall include the following features or functions:
 - a. When an obstruction or resistance to the opening swing is encountered, the operator will pause at that point, then attempt to continue opening the door. If the obstruction or resistance remains, the operator will again pause the door.
 - b. Easily accessible main power and maintain hold open switches will be provided on the operator.
 - c. An electronically controlled clutch to provide adjustable opening force.
 - d. A microprocessor to control all motor and clutch functions.
 - e. An on-board power supply capable of delivering both 12V and 24V outputs up to a maximum of 1.0 ampere combined load.
 - f. All input and output power wiring shall be protected by slow blow fuses. These fuses shall be easily replaceable without special tools or component replacement.
5. Actuators shall have a stainless steel touch plate that measures 4-1/2" in diameter and features a blue filled handicap symbol. The actuator shall be weather resistant and provide normally open momentary contacts. The actuator is designed to mount in a standard single gang box (2" wide, 4" high, and 2" deep).
6. Power door operators will provide a two (2) year warranty.
7. The contractor shall furnish a certificate executed by a representative of the manufacturer of the door closers that all closers have been inspected and adjusted, are operating as designed and have been installed in accordance with the manufacturer's instructions.
8. Installation of the automatic door operators shall be done by a trained installer skilled in the installation of automatic door operators and equipment. Factory training provided by the operator manufacturer is recommended. All low voltage switch hookups are the responsibility of the operator installer, as well as temporary wiring hookup to plug into wall outlet for test of system. Final hookup of 115VAC power will be handled by and coordinated with the general contractor's electrical contractor.

I. Overhead Door Holders:

1. Acceptable manufacturers:
 - a. Glynn Johnson, Division of Ingersoll-Rand

- b. Rixson Firemark
 - 2. Characteristics:
 - a. Provide heavy duty door holders of stainless steel.
 - b. Holder to be installed with the jamb bracket mounted on the stop.
- J. Floor Stops and Wall Bumpers:
 - 1. Acceptable manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 - 2. Characteristics: Refer to Hardware Headings.
- K. Door Bolts/Coordinators:
 - 1. Acceptable manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 - 2. Characteristics:
 - a. Flush bolts to be forged brass 6-3/4" x 1", with 1/2" diameter bolts. Plunger to be supplied with milled surface one side which fits into a matching guide.
 - b. Automatic flush bolts to be UL listed as top and bottom bolts on a pair of classified fire doors. Bolt construction to be of rugged steel and brass components.
 - c. Self-latching flush bolts to be UL listed as top and bottom bolts on a pair of classified fire doors. Bolt construction to be of rugged steel and brass components.
 - d. Automatic flush bolts and self-latching flush bolts shall be UL listed for fire door application without bottom bolts (LBB).
 - e. Coordinator to be soffit mounted non-handed fully automatic UL listed coordinating device for sequential closing of paired doors with or without astragals.
 - f. Provide filler pieced to close the header. Provide brackets as required for mounting of soffit applied hardware.
- L. Push Plates:
 - 1. Acceptable Manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 - 2. Characteristics:
 - a. Exposed Fasteners: Provide manufacturers standard exposed fasteners.
 - b. Material to be extruded/forged, stainless steel, per the Hardware Headings.
 - c. Provide plated sized as shown in Hardware Headings.
- M. Door Pulls & Pull Plates:
 - 1. Acceptable Manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 - 2. Characteristics:
 - a. Provide concealed thru-bolted trim on back to back mounted pulls, but not for single units.
 - b. Material to be extruded/forged/cast, stainless steel.
 - c. Provide units sized as shown in Hardware Headings.
- N. Push Pull Sets:
 - 1. Acceptable Manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing

2. Characteristics:
 - a. Provide mounting systems as shown in hardware sets.
 - b. Material to be (description - i.e. solid rod, tubular, cast etc.) stainless steel.
 - c. Provide Push/Pull sets sized as shown in Hardware Headings.
- O. Protective Plates:
 1. Acceptable Manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 2. Characteristics:
 - a. Provide manufacturers standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.
 - b. Materials:
 - 1) Metal Plates: Stainless Steel, .050 inch (U.S. 18 gage).
 3. Fabricate protection plates not more than 2 inches less than door width on hinge side and not more than 1 inch less than door width on pull side.
 4. Heights:
 - a. Kick plates to be 10 inches in height.
 - b. Mop plates to be 4 inches in height.
 - c. Armor plates to be 34 inches in height. Armor plates on fire doors to comply with NFPA 80.
- P. Thresholds:
 1. Acceptable Manufacturers:
 - a. National Guard Products, Inc.
 - b. Reese Industries
 - c. Zero Weather-stripping Co., Inc.
 2. Types: Indicated in Hardware Headings.
- Q. Weather-stripping:
 1. Acceptable Manufacturers:
 - a. National Guard Products, Inc.
 - b. Reese Industries
 - c. Zero Weather-stripping Co., Inc.
 2. Types: Indicated in Hardware Headings.
- R. Silencers:
 1. Acceptable Manufacturers:
 - a. Glynn Johnson
 - b. Ives
 - c. Rockwood Manufacturing
 2. Three for each single door; four for pairs of doors.
- S. Key Cabinet and System:
 1. Acceptable Manufacturers:
 - a. Telkee, Inc.
 2. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project.
 3. Provide hinged-panel type cabinet for wall mounting.
- T. Magnetic Door Holders
 1. Acceptable Manufacturers:
 - a. LCN, Division of Ingersoll-Rand
 - b. Rixson-Firemark

- c. Edwards
- 2. Wall mounted 24vdc units with finish to match door hardware.

2.2 MATERIALS AND FABRICATION

- A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.
- C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 1. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - 2. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of adequately fastening the hardware. Coordinate with wood doors and metal doors and frames where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.3 HARDWARE FINISHES

- A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).
- B. Provide finishes that match those established by ANSI or, if none established, match the Architect's sample.
- C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- D. The designations used to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
 - 1. Hinges (Exterior) 630 (US32D) Satin Stainless Steel
 - 2. Hinges (Interior) 652 (US26D) Satin Chrome Plated Steel
 - 3. Continuous Hinges 628 (US28) Clear Anodized Aluminum finish to match doors @ aluminum entrance systems
 - 4. Flush Bolts 626 (US26D) Satin Chrome Plated Brass/Bronze
 - 5. Locks 630 (US32D) Satin Stainless Steel
 - 6. Exit Devices 628 (US28) chassis, 626 (US26D) covers, and 630 (US32D) touchpads
 - 7. Door Closers 689 (AL) Powder Coat
 - 8. Push Plates 630 (US32D) Satin Stainless Steel

9. Pull Plates 630 (US32D) Satin Stainless Steel
10. Protective Plates 630 (US32D) Satin Stainless Steel
11. Door Stops 626 (US26D) Satin Chrome Plated Brass/Bronze
12. Overhead Holders 630 Satin Stainless Steel
13. Thresholds/627/628 (US27/US28)
14. Weather-stripping Aluminum

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.
 1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."
- F. Weather-stripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to function properly with final operation of heating and ventilating equipment.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Door Hardware Supplier's Field Service
 1. Inspect door hardware items for correct installation and adjustment after complete installation of door hardware.
 2. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.
 3. File written report of this inspection to Architect.
- D. Prior to project completion, representatives of the lock, exit device and overhead closer

manufacturer(s) shall inspect and adjust all units and certify that all units are installed in accordance with the manufacturer's instructions, and are regulated properly and functioning correctly. A written report shall be provided to the Architect as to the inspection and shall include appropriate certificates.

END OF SECTION

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Glass
- B. Glazing compounds and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 062000 - Finish Carpentry: Wood components with requirements for glass.
- B. Section 079005 - Joint Sealers: Sealant and back-up material.
- C. Section 081213 - Hollow Metal Frames: Glazed borrowed lites.
- D. Section 081416 - Flush Wood Doors: Glazed doors.
- E. Section 082500 - All-Glass Doors and Entrances.

1.3 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; current edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test; 2009.
- C. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2011.
- F. ASTM C1036 - Standard Specification for Flat Glass; 2006.
- G. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; 2004.
- H. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2009e1.
- I. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2009.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.
- K. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2009a.
- L. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 2009.
- M. GANA (SM) - FGMA Sealant Manual; Glass Association of North America; 2008.
- N. GANA (LGDG) - Laminated Glazing Reference Manual; Glass Association of North America; 2009.

1.4 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in

referenced glazing publications.

- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. Interspace: Space between lites of an insulating-glass unit.

1.5 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: Defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.6 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
 - 1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
 - 2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
 - 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
 - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.7 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: Submit five samples for each type of the following products; 12 inches square.
 - 1. Tinted glass.
 - 2. Coated glass.
 - 3. Insulating glass.
- C. Glazing Accessory Samples: Submit five samples for gaskets, sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For installers.
- G. Product Certificates: For glass and glazing products, from manufacturer.

- H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for insulating glass and glazing gaskets.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- I. Preconstruction adhesion and compatibility test report.
- J. Warranties: Sample of special warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- C. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Source Limitations for Glass: Obtain laminated glass and insulating glass from single source from single manufacturer for each glass type.
- E. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- G. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- H. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.11 WARRANTY

- A. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

2.3 GLASS MATERIALS

- A. Float Glass: All glazing is to be float glass unless otherwise indicated.
 1. Annealed Type: ASTM C1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
 2. Heat-Strengthened and Fully Tempered Types: ASTM C1048.
 3. Tinted Types: Color and performance characteristics as indicated.
 4. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.
 5. Manufacturers:
 - a. AGC Flat Glass North America, Inc: www.afgglass.com.
 - b. Guardian Industries Corporation: www.guardian.com.
 - c. Pilkington North America Inc: www.pilkington.com/na.
 - d. PPG Industries, Inc: www.ppgglazing.com.
 - e. Viracon, Apogee Enterprises, Inc: www.viracon.com.
 - f. Substitutions: Refer to Section 016000 - Product Requirements.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 1. Plastic Interlayer: 0.030 inch thick, minimum.
 2. Where fully tempered is specified or required, provide glass that has been tempered by the tong-less horizontal method.
 3. Manufacturers:
 - a. AGC Flat Glass North America, Inc: www.afgglass.com.
 - b. Cardinal Glass Industries: www.cardinalcorp.com.

- c. Viracon, Apogee Enterprises, Inc: www.viracon.com.
 - d. Substitutions: Refer to Section 016000 - Product Requirements.
- C. Glass-Ceramic Safety Glazing: UL- or WH-listed as fire-protection-rated glazing and complying with 16 CFR 1201 test requirements for Category II without the use of a surface-applied film.
- 1. 20-Minute Fire Doors: Hose stream test is not required.
 - 2. Manufacturers:
 - a. O'Keeffe's Inc. SAFTI Division; SAFTIFIRST.
 - b. SCHOTT North America Inc; Pyran Platinum L (laminated) Fire Rated Ceramic Glass.
 - c. SCHOTT North America Inc; Pyran Star L (laminated) Fire Rated Ceramic Glass.
 - d. Vetrotech Saint-Gobain North America;.
 - e. Substitutions: Refer to Section 016000 - Product Requirements.

2.4 LAMINATED BUTT-GLAZING

- A. Laminated Butt-Glazing Materials:
- 1. Glass laminated with 0.030 inch thick plastic interlayer; comply with ASTM C 1172.
 - 2. Comply with ASTM C 1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select) and ASTM C 1048.
 - 3. Thickness: 3/4 inch nominal thickness.
 - a. Outer Pane: 1/4" tinted tempered glass, tint color as selected
 - 1) Daylight Transmittance: 68 percent.
 - 2) Outside Reflectance: 7 percent maximum.
 - 3) Nighttime Winter U-Value: 1.02 BTU/hour/square foot maximum.
 - 4) Shading Coefficient: .59 maximum.
 - 5) Light to Solar gain (LSG): 1.34.
 - b. Inner Pane: 1/2 inch clear tempered glass.
 - 1) Comply with ASTM C 1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
 - 2) Comply with ASTM C 1048.
- B. Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 25, Uses NT, A, G, O; single component, neutral curing, non-sagging, non-staining, fungus resistant, non-bleeding.
- 1. Manufacturers:
 - a. Dow Corning Corporation; Product 999-A Silicone Building & Glazing Sealant: www.dowcorning.com.
 - b. Tremco Sealants; Product Spectrum 2: www.tremcosealants.com.
 - c. Substitutions: Refer to Section 016000 - Product Requirements.
 - 2. Color: Color as selected.
 - 3. Movement Capability: Plus and minus 25 percent.
 - 4. Service Temperature Range: -65 to 180 degrees F.
 - 5. Shore A Hardness Range: 15 to 35.

2.5 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
- 1. Neoprene complying with ASTM C 864.
 - 2. EPDM complying with ASTM C 864.
 - 3. Silicone complying with ASTM C 1115.
 - 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
- 1. Application: Use where soft compression gaskets will be compressed by inserting dense

compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.6 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 - 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Acceptable Manufacturers:
 - a. Dow Corning Corporation; 790.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Pecora Corporation; 890.
 - e. Sika Corporation, Construction Products Division; SikaSil-C990.
 - f. Tremco Incorporated; Spectrem 1.
 - g. Substitutions: Refer to Section 016000 - Product Requirements.
- C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. Acceptable Manufacturers:
 - a. BASF Building Systems; Omniseal 50.
 - b. Dow Corning Corporation; 795.
 - c. May National Associates, Inc.; Bondaflex Sil 295.
 - d. Pecora Corporation; 895.
 - e. Polymeric Systems, Inc.; PSI-641.
 - f. Sika Corporation, Construction Products Division; SikaSil-C995.
 - g. Tremco Incorporated; Spectrem 2.
 - h. Substitutions: Refer to Section 016000 - Product Requirements.
- D. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Acceptable Manufacturers:
 - a. Dow Corning Corporation; 799.
 - b. May National Associates, Inc.; Bondaflex Sil 200 GPN.
 - c. Polymeric Systems, Inc.; PSI-631.
 - d. Schnee-Morehead, Inc., an ITW company; SM5731 Poly-Glaze Plus.
 - e. Tremco Incorporated; Proglaze SSG.
 - f. Substitutions: Refer to Section 016000 - Product Requirements.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and

complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 2. Presence and functioning of weep systems.
 3. Minimum required face and edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will

leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover

horizontal framing joints by applying tapes to jambs and then to heads and sills.

- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 MANUFACTURER'S FIELD SERVICES

- A. Glass product manufacturers to provide field surveillance of the installation of their products.
- B. Monitor and report installation procedures and unacceptable conditions.

3.7 CLEANING AND PROTECTION

- A. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- C. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION

SECTION 092116 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Shaft wall system.
- E. Fire rated area separation walls.
- F. Acoustic insulation.
- G. Gypsum wallboard.
- H. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Exterior wind-load-bearing metal stud framing.
- B. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.
- C. Section 072100 - Thermal Insulation: Acoustic insulation.
- D. Section 079005 - Joint Sealers: Acoustic sealant.

1.3 REFERENCE STANDARDS

- A. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2001 with 2004 supplement. (replaced SG-971)
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2002 (Reapproved 2007).
- D. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2009)e1.
- E. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2009a.
- F. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.
- G. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2009a.
- H. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2008.
- I. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2010.
- J. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs;

2007.

- K. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2009a.
- L. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009.
- M. ASTM E413 - Classification for Rating Sound Insulation; 2010.
- N. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2010.
- O. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2009.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
- C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- E. Test Reports: For all stud framing products that do not comply with ASTM C645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- F. Fire Resistance Rated Assemblies: For fire resistance rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- G. STC Rated Assemblies: For STC rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- H. Samples: Submit five samples of predecorated gypsum board, 12 by 12 inches in size, illustrating finish color and texture.
- I. Samples: Submit five samples of gypsum board finished with proposed texture application, 12 by 12 inches in size, illustrating finish color and texture.

1.5 STORAGE AND HANDLING

- A. Store materials inside under cover and keep dry and protected against damage from weather, condensation, direct sunlight, construction traffic and other causes. Stack panels flat to prevent sagging.

1.6 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.
 - 1. Maintain one copy of standards at project site.
- B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 3 years of documented experience.
- C. Do not install interior products until installation areas are enclosed and conditioned.
- D. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 1. See PART 3 for finishing requirements.
- B. Interior Partitions Indicated as Acoustic: Provide completed assemblies with the following characteristics:
 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.2 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
 2. Dietrich Metal Framing: www.dietrichindustries.com.
 3. MarinoWare: www.marinoware.com.
 4. Telling Industries; Product Metal Drywall Framing Series: www.tellingindustries.com.
 5. Substitutions: See Section 016000 - Product Requirements.
- B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
 1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 - a. Acceptable Products:
 - 1) Dietrich Metal Framing; UltraSteel (tm): www.dietrichindustries.com.
 - 2) Clark Western Building Systems; UltraSteel (tm): www.clarkwestern.com.
 2. Studs: "C" shaped with flat or formed webs with knurled faces.
 3. Runners: U shaped, sized to match studs.
 4. Ceiling Channels: C shaped.
 5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
 6. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through one leg only.
 - a. Manufacturers - Resilient Furring Channels:
 - 1) Same manufacturer as other framing materials.
 - 2) Substitutions: See Section 016000 - Product Requirements.
- C. Loadbearing Studs for Application of Gypsum Board: As specified in Section 054000.
- D. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.

1. Manufacturers - Shaft Wall Studs and Accessories:
 - a. Same manufacturer as other framing materials.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- F. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot dipped galvanized coating.
 3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
 4. Deflection and Firestop Track:
 - a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
 - b. Acceptable Products:
 - 1) "Posi Clip" by Fire Trak Corporation.
 - 2) "The System" by Metal-Lite, Inc.
 5. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.

2.3 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 1. Georgia-Pacific Gypsum LLC: www.gp.com/gypsum.
 2. Lafarge North America Inc: www.lafargenorthamerica.com.
 3. National Gypsum Company: www.nationalgypsum.com.
 4. Temple-Inland Inc: www.templeinland.com.
 5. USG Corporation: www.usg.com.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Wallboard: Gypsum wallboard as defined in ASTM C 1396/C 1396M; sizes to minimize joints in place; ends square cut.
 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 1/2 inch.
 4. Paper-Faced Products:
 - a. Georgia-Pacific Gypsum LLC; ToughRock Gypsum Wallboard.
 - b. National Gypsum Company; Gold Bond Brand Gypsum Wallboard.
 - c. Temple-Inland Inc; Gypsumboard and Gypsum Board Fire Resistant Panels Type X and Type TGC.
 - d. USG Corporation; Sheetrock Brand Gypsum Panels.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Ceiling Board: Special sag-resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 1. Application: Ceilings, unless otherwise indicated.
 2. Thickness: 1/2 inch.
 3. Edges: Tapered.

4. Products:
 - a. Georgia-Pacific Gypsum LLC; ToughRock CD Ceiling Board.
 - b. National Gypsum Company; High Strength Brand Ceiling Board.
 - c. Temple-Inland Inc; Span24 Ceiling Board.
 - d. USG Corporation; Sheetrock Brand Sag-Resistant Interior Gypsum Ceiling Board.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
 1. Paper Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 2. Products:
 - a. CertainTeed Corporation; ProRoc Brand Shaftliner Type X.
 - b. National Gypsum Company; Gold Bond Brand 1" Fire-Shield Shaftliner.
 - c. Temple-Inland Inc; SilentGuard Gypsum Shaftliner.
 - d. USG Corporation; Sheetrock Gypsum Liner Panels.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.4 ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: As indicated on the drawings.
- B. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.
- C. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
 1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 2. Ready-mixed vinyl-based joint compound.
- D. Trim Accessories:
 1. Interior Trim: ASTM C 1047
 - a. Material: Galvanized or aluminum coated steel or rolled zinc.
 - b. Shapes:
 - 1) LC Bead: J-shaped; exposed long flange receives joint compound.
 - 2) Expansion (control) joint.
 2. Cornerbead: Grabber Construction Products; "No-Coat Pre-finished Cornerbead".
- E. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.
- F. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.
- G. Nails for Attachment to Wood Members: ASTM C514.
- H. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence. Examine areas and substrates, with Installer present, and including welded hollow metal frames and framing, for compliance with requirements and other conditions.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
 - 2. Install studs at spacing required to meet performance requirements.
- B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.
 - 1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
 - 2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.3 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
 - 1. Level ceiling system to a tolerance of 1/1200.
 - 2. Laterally brace entire suspension system.
 - 3. Install bracing as required at exterior locations to resist wind uplift.
- C. Studs: Space studs as permitted by standard.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
 - 1. Orientation: Horizontal.
 - 2. Spacing: As indicated.
- F. Acoustic Furring: Install resilient channels at maximum 24 inches on center. Locate joints over framing members.
- G. Furring for Fire Ratings: Install as required for fire resistance ratings indicated and to GA-600 requirements.
- H. Blocking: Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, and hardware. Bolt or screw steel channels to studs.

3.4 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

1. Place one bead continuously on substrate before installation of perimeter framing members.
2. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes.

3.5 BOARD INSTALLATION

- A. Comply with ASTM C 840 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing. Install panels with face side out. Do not place tapered edges against cut edges or ends. Do not make joints other than control joints at corners of framed openings.
 1. Stagger abutting end joints not less than on framing member in alternate courses of panels.
 2. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire resistance rated assembly.
 3. Exception: Tapered edges to receive joint treatment at right angles to framing.
- C. Form control and expansion joints with space between edges of adjoining gypsum panels.
- D. Double-Layer Non-Rated: Use gypsum board for first layer, placed parallel to framing or furring members, with ends and edges occurring over firm bearing. Use glass mat faced gypsum board at exterior walls and at other locations as indicated. Place second layer perpendicular to framing or furring members. Offset joints of second layer from joints of first layer.
- E. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- F. Installation on Metal Framing: Use screws for attachment of all gypsum board.

3.6 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints in accordance with ASTM C 840, consistent with lines of building spaces and as indicated.
 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
 2. At exterior soffits, not more than 30 feet apart in both directions.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.7 JOINT TREATMENT

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual compound from adjacent surfaces.
- B. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- C. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile

- and fixed cabinetry.
- 3. Taping, filling and sanding is not required at base layer of double layer applications.
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.8 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.9 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction and other causes during the remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy, or splotchy surface contamination and discoloration.

3.10 FINISH LEVEL SCHEDULE

- A. Level 1: Above finished ceilings concealed from view.
- B. Level 2: Utility areas and areas behind cabinetry.
- C. Level 3: Walls scheduled to receive textured wall finish.
- D. Level 4: Walls and ceilings scheduled to receive flat or eggshell paint finish.
- E. Level 5: Walls and ceilings scheduled to receive semi-gloss or gloss paint finish.

END OF SECTION

SECTION 093000 - TILE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Tile for floor applications.
- B. Stone thresholds.
- C. Non-ceramic trim.

1.2 RELATED REQUIREMENTS

- A. Section 079005 - Joint Sealers.
- B. Section 092116 - Gypsum Board Assemblies: Installation of tile backer board.

1.3 REFERENCE STANDARDS

- A. ANSI/ASSE A10.20 - Safe Operating Practices for Tile, Terrazzo, and Marble Work (2006).
- B. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile; 2011.
- C. ANSI A137.2 - American National Standard Specifications for Glass Tile; 2011.
- D. TCNA (HB) - Handbook for Ceramic Tile Installation; 2011.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include manufacturer's written instructions for installing tile, grouts and adhesives.
- C. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- D. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- E. Samples: Mount tile and apply grout on five plywood panels, minimum 18 x 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- G. Qualification Data: For Installer.
- H. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
- I. Material Test Reports: For each tile setting and grouting product.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of The Tile Council of North America Handbook and ANSI A108 Series/A118 Series/A136.1 on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products

specified in this section, with minimum 5 years of documented experience.

- C. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.
- D. Obtain tile from same production run and of consistent quality and appearance and physical properties from one source or producer for each contiguous area.
- E. Obtain all installation from a single source manufacturer from one source or producer.
- F. Obtain other products specified in this Section through one source from a single manufacturer for each product including:
 - 1. Thresholds
 - 2. Metal Edge Strips.

1.6 PERFORMANCE REQUIREMENTS

- A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ATM C 1028:
 - 1. Level Surfaces: Minimum 0.6.
 - 2. Ramps and Wet Areas: Minimum 0.8.

1.7 PRE-INSTALLATION MEETING

- A. Convene one week before starting work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.9 FIELD CONDITIONS

- A. Do not install adhesives in an unventilated environment.
- B. Maintain ambient and substrate temperature of 50 degrees F to 90 degrees F during installation of mortar materials. Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at levels specified.

1.10 EXTRA MATERIALS

- A. Provide 2 percent of each size, color, and surface finish of tile specified.

1.11 WARRANTY

- A. Provide to the Owner the manufacturer's full system warranty for a period of not less than 10 years from the Date of Material Completion.

PART 2 - PRODUCTS

2.1 TILE

- A. Tile Types: See drawings for type, color, finish and manufacturer.

2.2 SURFACE PREPARATION MATERIALS

- A. Cementitious Self-Leveling Underlayment: Dry, blend of copolymers, Portland cement, post industrial and consumer recycled aggregate and inorganic chemicals, for leveling and patching to bring substrate into compliance with flatness tolerances.
1. Basis of Design: LevelLite by Custom Building Products:
www.custombuildingproducts.com.
 2. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 3. Substitutions: See Section 016000 - Product Requirements.
- B. Cementitious Patching and Repair Compound: Finely sanded polymer modified cementitious patching compound, to repair concrete substrates.
1. Basis of Design: Skim Coat and Patch by Custom Building Products:
www.custombuildingproducts.com.
 2. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 3. Substitutions: See Section 016000 - Product Requirements.

2.3 WATERPROOF MEMBRANE

- A. Waterproofing Membrane: Liquid applied waterproofing membrane complying with ANSI A118.12 for all waterproofing applications indicated. Membrane to tie into drain flanges and shall be flashed up perimeter walls and in-field penetrations to form a waterproofed area.
1. Basis of Design: RedGard Waterproofing and Crack Prevention Membrane by Custom Building Products: www.custombuildingproducts.com.
 2. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 - c. MAPEI Corporation: www.mapei.com.
 3. Substitutions: See Section 016000 - Product Requirements.

2.4 CRACK ISOLATION MEMBRANE

- A. High Performance Crack Isolation Membrane: Asphaltic self-adhering membrane, complies with ANSI A118.12 for repair of all cracks per manufacturers written instructions. Provide full field application where indicated. Crack isolation membrane shall allow relaxation of saw cut, control, contraction and cold joints to the nearest grout joint as per TCNA F125 partial.
1. Thickness: 30 mils, minimum.
 2. Basis of Design: CrackBuster Pro by Custom Building Products:
www.custombuildingproducts.com.
 3. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 - c. MAPEI Corporation: www.mapei.com.
 4. Substitutions: See Section 016000 - Product Requirements.

2.5 THIN SET BOND COAT MATERIALS

- A. Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.
 - 1. Basis of Design: MegaLite Thin Set Mortar by Custom Building Products: www.custombuildingproducts.com.
 - 2. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.6 GROUT MATERIALS

- A. Epoxy Grout: ANSI A118.3, 100% solids epoxy mortar and non-sagging grout system; use for all porcelain tile applications. Colors: as indicated on the drawings.
 - 1. Basis of Design: Custom Building Products: www.custombuildingproducts.com
 - 2. Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 - c. Substitutions: See Section 016000 - Product Requirements.
 - 3. Applications: Where indicated.
 - 4. Color(s): As indicated on the drawings.
 - 5. Grout Joint Width: For use on all grout joint from 1/16" to 1/2" wide.

2.7 JOINT SEALANT

- A. Tile Sealant: Gunnable, silicone sealant; moisture and mildew resistant type as per ASTM C920 and TCNA EJ171 for all applicable movement joints.
 - 1. Applications: Between tile and plumbing fixtures.
 - 2. Color(s): As selected by Design Professional from manufacturer's full line.
 - 3. Basis of Design: Commercial 100% Silicone Caulk by Custom Building Products: www.custombuildingproducts.com.
 - 4. Other Acceptable Manufacturers:
 - a. Bostik: www.bostik.com.
 - b. LATICRETE International, Inc.: www.laticrete.com.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.8 TILE ACCESSORIES

- A. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications: Use in the following locations:
 - a. Open edges of wall tile.
 - b. Open edges of floor tile.
 - c. Wall corners, outside and inside.
 - d. Transition between floor finishes of different heights.
 - e. Thresholds at door openings.
 - f. Expansion and control joints, floor and wall.
 - g. Floor to wall joints.
 - h. Borders and other trim as indicated on drawings.
 - i. Balcony and terrace edge trim and fascia.
 - 2. Acceptable Manufacturers:
 - a. Schluter-Systems: www.schluter.com.
 - b. Genesis APS International: www.genesis-aps.com.
 - c. Substitutions: See Section 016000 - Product Requirements.

- B. Thresholds: Marble, white or gray, honed finish; 2 inches wide by full width of wall or frame

opening; 1/2 inch thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.

1. Applications: Provide at the following locations:
 - a. At doorways where tile terminates.
 - b. At open edges of floor tile where adjacent finish is a different height.

2.9 ACCESSORY MATERIALS

- A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
- C. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within the following limits:
 1. Moisture emission rate: Not greater than 3 lb per 1000 sq ft per 24 hours when tested using calcium chloride moisture test kit for 72 hours.
 2. Alkalinity: pH range of 5-9.
- D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.3 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108 Series/A118 Series/A136.1, manufacturer's instructions, and TCA Handbook recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints without voids, cracks, excess mortar, or excess grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Install thresholds where indicated.

- H. Sound tile after setting. Replace hollow sounding units.
- I. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
- J. Allow tile to set for a minimum of 48 hours prior to grouting.
- K. Grout tile joints.
- L. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.4 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over exterior concrete substrates, install in accordance with The Tile Council of North America Handbook Method F102, withgrout.
- B. Over interior concrete substrates, install in accordance with TCA Handbook Method F113, latex-portland cement bond coat, with grout, unless otherwise indicated.
 - 1. Use crack isolation membrane under all tile unless other underlayment is indicated.
 - 2. Where waterproofing membrane is indicated, install in accordance with TCA Handbook Method F122, with latex-portland cement grout.
- C. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes with flush with top of tile.
- D. Grout Sealer: Apply grout sealer to grout joints according to grout sealer manufacturer's written instructions.

3.5 CLEANING

- A. On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove latex-portland cement grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
- B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage and wear.
- C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.6 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.
- B. Protect finished floor surface in accordance with TCNA "Protecting New Tilework".

END OF SECTION

SECTION 095100 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.2 RELATED REQUIREMENTS

- A. Section 079005 - Joint Sealers: Acoustical sealant.

1.3 REFERENCE STANDARDS

- A. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2008.
- B. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2011.
- C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2008e1.
- D. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
- C. Product Data: Provide data on suspension system components.
- D. Samples: Submit five full size samples illustrating material and finish of acoustical units.
- E. Samples: Submit five samples each, 8 inches long, of suspension system main runner.
- F. Manufacturer's Installation Instructions: Indicate special procedures.

1.5 QUALITY ASSURANCE

- A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL for the fire resistance indicated.
- B. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Seismic Standard: Comply with the following:
 - 1. ASTM E580.
 - 2. CISCA's "Recommendations for Direct Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2".
 - 3. CISCA's "Guidelines for Seismic Restraint of Direct Hung Suspended Ceiling Assemblies - Seismic Zones 3 & 4".

1.6 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.7 PROJECT CONDITIONS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Install acoustical units after interior wet work is dry.

1.8 EXTRA MATERIALS

- A. See Section 016000 - Product Requirements, for additional provisions.
- B. Provide 2.0 percent of total acoustical unit area of each type of acoustical unit for Owner's use in maintenance of project.
- C. Provide 2.0 percent of total of each concealed grid and exposed component for Owner's use in maintenance of project.

PART 2 - PRODUCTS

2.1 ACOUSTICAL UNITS

- A. Acoustical ceiling panels and suspension systems shall match existing as indicated on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected ceiling plan.
- D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- E. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.
- F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- H. Do not support components on main runners or cross runners if weight causes total dead load

to exceed deflection capability.

- I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- J. Do not eccentrically load system or induce rotation of runners.
- K. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

3.3 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units with pattern parallel to longest room axis.
- D. Fit border trim neatly against abutting surfaces.
- E. Install units after above-ceiling work is complete.
- F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- G. Cutting Acoustical Units:
 - 1. Cut to fit irregular grid and perimeter edge trim.
 - 2. Make field cut edges of same profile as factory edges.
- H. Where round obstructions occur, provide preformed closures to match perimeter molding.
- I. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.
- J. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.
- K. Install hold-down clips on panels within 20 ft of an exterior door.

3.4 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION

SECTION 096500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.

1.3 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2010e1.
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2008.
- C. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile; 2004 (Reapproved 2010)e1.
- D. ASTM F1861 - Standard Specification for Resilient Wall Base; 2008.
- E. ASTM F1913 - Standard Specification for Vinyl Sheet Floor Covering Without Backing; 2004 (Reapproved 2010).
- F. ASTM F 2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2009.
- G. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; National Fire Protection Association; 2011.
- H. RFCI - Recommended Work Practices for Removal of Resilient Floor Coverings; Resilient Floor Covering Institute; 1998.
- I. SCS (CPD) - SCS Certified Products; Scientific Certification Systems; current listings at www.scs-certified.com.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate seaming plan.
- D. Selection Samples: Submit five samples for Architect's initial selection.
- E. Verification Samples: Submit five samples, 12x12 inch in size illustrating color and pattern for each resilient flooring product specified.
- F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 016000 - Product Requirements, for additional provisions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect roll materials from damage by storing on end.

1.6 FIELD CONDITIONS

- A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

1.7 EXTRA MATERIALS

- A. See Section 016000 - Product Requirements, for additional provisions.
- B. Provide 2 percent of flooring, 5 percent of base, of each type and color specified.

PART 2 - PRODUCTS

2.1 TILE FLOORING

- A. Vinyl Composition Tile: See drawings for type, color, finish and manufacturer.

2.2 RESILIENT BASE

- A. Resilient Base: See drawings for type, color, finish and manufacturer.
1. Height: Match existing.

2.3 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
- C. Moldings, Transition and Edge Strips: Same material as flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.
- C. Verify that concrete sub-floor surfaces are dry enough and ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F710; obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
1. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed

- with installation only after substrates pass testing.
- 2. Moisture Testing: Perform tests recommended by manufacturer and as follows. Proceed with installation only after substrates pass testing.
 - a. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.
- D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Remove existing resilient flooring and flooring adhesives; follow the recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings.
- B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is cured.
- D. Clean substrate.
- E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 - 1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
 - 2. Resilient Strips: Attach to substrate using adhesive.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
- I. Install feature strips where indicated.

3.4 TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.
- B. Spread only enough adhesive to permit installation of materials before initial set.
- C. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern.
- E. Where floor finishes are different on opposite sides of door, terminate flooring under centerline

of door.

- F. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- G. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.5 RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.6 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's instructions.

3.7 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.2 RELATED REQUIREMENTS

- A. Section 017419 - Construction Waste Management and Disposal: Reclamation/Recycling of new carpet tile scrap.
- B. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.
- C. Section 096800 - Carpeting: Broadloom carpet.

1.3 REFERENCE STANDARDS

- A. CRI (CIS) - Carpet Installation Standard; Carpet and Rug Institute; 2009.
- B. CRI 104 - Standard for Installation of Commercial Textile Floorcovering Materials; Carpet and Rug Institute; 2002.
- C. CRI (GLA) - Green Label Testing Program - Approved Adhesive Products; Carpet and Rug Institute; Current Edition.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate layout of joints.
- C. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- D. Samples: Submit five carpet tiles illustrating color and pattern design for each carpet color selected.
- E. Submit five, 12 inch long samples of edge strip.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: A firm with not less than 7 years experience installation of carpeting similar to that required for this project, and who is approved and certified by the Floor Covering Installation Board (and the carpet manufacturer) or who can demonstrate compliance with its certification program requirements.
- C. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification

indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1. Source of Materials:
 - a. Carpet Materials: To ensure matching of quality, color, pattern, and texture, install materials produced from same dye lot and production run. Where materials cannot be obtained from a single lot or production run, notify the Architect so that the extent and use of each lot or run can be controlled.
 - b. Carpet Material, Installation Materials and Accessories: Provide material obtained from one source for each type of material used in the Work. Do not change source or brands of materials during progress of Work.

1.6 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.
- B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
- C. Ventilate installation area during installation and for 72 hours after installation.
- D. Environmental Limitations: Do not install carpet until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- E. Subfloor Moisture Conditions: Moisture emission rate of not more than 3lb/1000 sq.ft./24 hours (14.6 kg/1000 sq.m/24 hours) when tested by calcium chloride moisture test in compliance with CRI 104, 6.2.1, with subfloor temperatures not less than 55 deg F (12.7 deg C).
- F. Subfloor Alkalinity Conditions: A ph range of 5 to 9 when subfloor is wetted with potato water and pHydron paper is applied.
- G. Do not install carpet over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by adhesive manufacturer.
- H. Conditioning:
 1. Materials: Condition carpet materials and adhesive in the area they are to be installed, in accordance with manufacturer's instructions. Where such instructions are not published, obtain conditioning instructions in writing from the manufacturer.

1.7 EXTRA MATERIALS

- A. See Section 016000 - Product Requirements, for additional provisions.
- B. Maintenance / Replacement Materials: Before commencement of carpet installation, deliver stock of replacement materials to Owner's designated storage space. Furnish full size units, matching installed materials, packaged and marked for identification as extra run material.
 1. Deliver not less than 5% of the total square yardage, as manufactured for installation, of each carpet Type and Pattern. Maintenance materials are exclusive of material required to properly complete installation.
 - a. Furnish maintenance materials from same production run as materials installed.
 2. Package replacement materials with protective covering recommended by manufacturer, and identified with appropriate labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer:

1. Shaw: www.shawfloors.com.
- B. Other Acceptable Manufacturers:
 1. Tandus: www.tandus.com.
 2. Interface, Inc: www.interfaceinc.com.
 3. Lees Carpets: www.leescarpets.com.
 4. Milliken & Company: www.milliken.com.
 5. Substitutions: See Section 016000 - Product Requirements.

2.2 CARPET TILE C1

- A. Carpet Tile C1: Subject to compliance with requirements, provide the following:
 1. Basis of Design Manufacturer: Shaw: www.shawfloors.com.
 - a. Color: As indicated on the drawings.
 - b. Pattern: As indicated on the drawings.
 - c. Size: 24 inch x 24 inch.

2.3 ACCESSORIES

- A. Sub-Floor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Vinyl, color as selected.
- C. Adhesives: Acceptable to carpet tile manufacturer, compatible with materials being adhered; maximum VOC of 50 g/L; CRI Green Label certified; in lieu of labeled product, independent test report showing compliance is acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.
 1. Test in accordance with ASTM F710.
 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- D. Verify that concrete sub-floor surfaces are ready for carpet tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by carpet tile manufacturer and adhesive materials manufacturer.
- E. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

- D. Vacuum clean substrate.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions and CRI Carpet Installation Standard.
- C. Install carpet tile in accordance with manufacturer's instructions and CRI 104.
- D. Blend carpet from different cartons to ensure minimal variation in color match.
- E. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- F. Locate change of color or pattern between rooms under door centerline.
- G. Fully adhere carpet tile to substrate.
- H. Trim carpet tile neatly at walls and around interruptions.
- I. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

SECTION 099000 - PAINTING AND COATING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints and other coatings.
- C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 - 2. Elevator pit ladders.
 - 3. Exposed surfaces of steel lintels and ledge angles.
 - 4. Prime surfaces to receive wall coverings.
 - 5. Mechanical and Electrical:
 - a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
 - b. On the roof and outdoors, paint all equipment that is exposed to weather or to view, including that which is factory-finished.
 - c. Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Non-metallic roofing and flashing.
 - 6. Stainless steel, anodized aluminum, bronze, terne, and lead items.
 - 7. Marble, granite, slate, and other natural stones.
 - 8. Floors, unless specifically so indicated.
 - 9. Ceramic and other tiles.
 - 10. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 11. Glass.
 - 12. Acoustical materials, unless specifically so indicated.
 - 13. Concealed pipes, ducts, and conduits.

1.2 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.
- B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2011.
- C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.
- D. GreenSeal GS-11 - Paints; 1993.

- E. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings; Fourth Edition.

1.3 DEFINITIONS

- A. Conform to ASTM D 16 for interpretation of terms used in this section.
1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85 degree meter.
 2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60 degree meter.
 3. Semi-gloss refers to a medium sheen finish with a gloss range between 35 and 70 when measured at a 60 degree meter.
 4. Full gloss refers to high sheen finish with a gloss range more than 70 when measured at a 60 degree meter.

1.4 SUMMARY

- A. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain neutral. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect shall select from the full range of colors and finishes available.
1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory applied final finish.
- B. Do not paint prefinished item, concealed surfaces, finished metal surfaces, operating parts and labels.
1. Prefinished items include the following factory finished components:
 - a. Architectural woodwork.
 - b. Acoustical wall panels.
 - c. Metal toilet enclosures.
 - d. Elevator entrance doors and frames.
 - e. Elevator equipment.
 - f. Finished mechanical and electrical equipment.
 - g. Light fixtures.
 2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Foundation spaces.
 - b. Furred areas.
 - c. Ceiling plenums.
 - d. Utility tunnels.
 - e. Pipe spaces.
 - f. Duct shafts.
 - g. Elevator shafts.
 3. Finished metal surfaces include the following:
 - a. Anodized aluminum.
 - b. Copper and copper alloys.
 4. Operating parts include moving parts of operating equipment and the following:
 - a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
 5. Labels: Do not paint over UL, FMG or other code required labels or equipment names, identification, performance ratings or nomenclature plates.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on all finishing products, including VOC content. Use of paint products containing greater than 6 one-hundredths of one percent (0.06%) lead by weight is prohibited.
- C. Samples: Submit five paper chip samples, 8x10 inch in size illustrating range of colors and textures available for each surface finishing product scheduled.
- D. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
- E. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.
- F. Manufacturer's Instructions: Indicate special surface preparation procedures.
- G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.
- H. Qualification Data: For Applicator.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five years experience.
- C. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

1.7 REGULATORY REQUIREMENTS

- A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.8 MOCK-UP

- A. See Section 014000 - Quality Requirements, for general requirements for mock-up.
- B. Provide door and frame assembly illustrating paint coating color, texture, and finish.
- C. Locate where directed.
- D. Mock-up may not remain as part of the work.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.10 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.11 EXTRA MATERIALS

- A. Supply five gallons of each color; store where directed.
- B. Label each container with color in addition to the manufacturer's label.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
- B. Paints and Coatings:
 - 1. Benjamin Moore & Co: www.benjaminmoore.com.
 - 2. PPG Industries, Inc (PPG): www.porterpaints.com.
 - 3. Sherwin-Williams: www.sherwin-williams.com.

2.2 INTERIOR PRIMERS

- A. Block Fillers: Factory formulated latex block filler for interior applications.
 - 1. Benjamin Moore; Super Spec Masonry Interior/Exterior Hi Build Block Filler No. 206: Applied at a dry film thickness of not less than 8.5 mils.
 - 2. PPG Industries: 6-15 SpeedHide Interior/Exterior Masonry Hi Fill Latex Block Filler: Applied at a dry film thickness of not less than 7.0 mils.
 - 3. Sherwin-Williams; Preprite Interior/Exterior Latex Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.
- B. Interior Concrete and Masonry Primers: Factory formulated alkali resistant acrylic interior primer for interior application.
 - 1. Benjamin Moore; Regal FirstCoat Interior Latex Primer & Underbody No. 216: Applied at a dry film thickness of not less than 1.0 mil.
 - 2. PPG Industries: 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mils.
 - 3. Sherwin-Williams; Loxon Concrete & Masonry Primer/Sealer Interior/Exterior Latex A24W8300: Applied at a dry film thickness of not less than 2.1 mils.
- C. Interior Gypsum Board Primers: Factory formulated latex-based primer for interior application.
 - 1. Benjamin Moore; Regal FirstCoat Interior Latex Primer & Underbody No. 216: Applied at a dry film thickness of not less than 1.0 mil.
 - 2. PPG Industries: 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mils.

3. Sherwin-Williams; High Build Interior Latex Primer B28W08601: Applied at a thickness recommended by the manufacturer.
- D. Interior Gypsum Board Primers: Factory formulated high-solids 100% acrylic-based primer with mildewcide for interior application over coated glass-mat faced panels.
 1. PPG Industries: 17-921 Series Seal Grip Interior/Exterior 100% Acrylic Universal Primer/Sealer. Applied at a dry film thickness of not less than 1.5 mils.
 2. Pratt and Lambert Paints: SUPRIME Interior latex Enamel Undercoater Z1013/F1013. Applied at a dry film thickness of not less than 1.5 mils.
 3. Sherwin-Williams: Builders Solution. Applied at a dry film thickness of not less than
- E. Interior Wood Primers: Factory formulated latex-based primer for interior wood door application.
 1. Benjamin Moore; Fresh Start All Purpose 100% Acrylic Primer #023: Applied at a dry film thickness of not less than 1.2 mil.
 2. PPG Industries: Pittsburgh Paints 6-855 SpeedHide Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.0 mils.
 3. Sherwin-Williams; PrepRite ProBlock Latex Primer, B51 Series. Applied at a dry film thickness of not less than 1.4 mils.
- F. Interior Ferrous Metal Primers; Factory formulated quick drying rust inhibitive latex-based metal primer.
 1. Benjamin Moore; Super Spec HP Acrylic Metal Primer P04. Applied at a dry film thickness of not less than 1.7 - 2.3 mils.
 2. PPG Industries; Pitt-Tech/Pitt-Tech Plus DTM Primer, 90 Series. Applied at a dry film thickness as recommended by the manufacturer.
 3. Sherwin-Williams; Pro Industrial Procryl Universal Primer, B66-310 Series. Applied at a dry film thickness of not less than 2.0 - 4.0 mils.

2.3 INTERIOR FINISH COATS

- A. Interior Semi-gloss Acrylic Enamel: Factory formulated semi-gloss acrylic latex enamel for interior application.
 1. Benjamin Moore; Satin Impervo Alkyd low Lustre Enamel No. 235: Applied at a dry film thickness of not less than 1.3 mils.
 2. PPG Industries; 80-510 Series Wallhide Low Odor Interior Enamel Wall and Trim Semi-Gloss Oil: Applied at a dry film thickness of not less than 1.5 mils.
 3. Sherwin-Williams; Classic 99 Interior Alkyd Semi-Gloss Enamel A-40 Series: Applied at a dry film thickness of not less than 1.7 mils.
- B. Interior Satin Acrylic Epoxy Paint: Factory-formulated satin water-borne acrylic-epoxy paint for interior application.
 1. Benjamin Moore; 524 AURA Waterborne Acrylic Eggshell Enamel. Applied at a dry film thickness of not less than 2.0 mils.
 2. PPG Industries; Pitt-Glaze WB1 No. 16-510: Applied at a dry film thickness of not less than 1.5 mils.
 3. Sherwin-Williams; Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45-150 Series. Applied at a dry film thickness of not less than 1.5 mils.
- C. Interior Satin Acrylic Paint: Factory-formulated satin acrylic-emulsion latex paint for interior application.
 1. Benjamin Moore; Aura Satin Waterborne Interior Paint C274: Applied at a dry film thickness of not less than 1.3 mils.
 2. PPG Industries, Inc.: PPG 6-3511 Speedhide Interior Satin Acrylic Latex: Applied at a dry film thickness of not less than 1.3 mils.
 3. Sherwin-Williams; SuperPaint Interior Latex Satin Wall Paint, A87 Series: Applied at a dry film thickness as recommended by the manufacturer's written instructions.

2.4 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 - 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each coating material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content:
 - 1. Provide coatings that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:
 - 1) Opaque, Flat: 50 g/L, maximum.
 - 2) Opaque, Nonflat: 150 g/L, maximum.
 - 3) Opaque, High Gloss: 250 g/L, maximum.
 - 4) Varnishes: 350 g/L, maximum.
 - c. Architectural coatings VOC limits of State in which the project is located.
 - d. USGBC LEED-NC Rating System, Version 2.2, EQ Credit 4.2; for interior wall and ceiling finish (all coats), anti-corrosive paints on interior ferrous metal, clear wood stains and finishes, sanding sealers, other sealers, shellac, and floor coatings.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- D. Colors: As indicated on drawings
 - 1. Extend colors to surface edges; colors may change at any edge as directed by Architect.
 - 2. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.5 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin application of coatings until substrates have been properly prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 3. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.2 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or repair existing coatings that exhibit surface defects.
- D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- E. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
- F. Seal surfaces that might cause bleed through or staining of topcoat.
- G. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- H. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- I. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.
- J. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- K. Corroded Steel and Iron Surfaces to be Painted: Prepare using at least SSPC-PC 2 (hand tool cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).
- L. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.
- M. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
- N. Interior Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.
- O. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.3 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's instructions.
- C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- E. Apply each coat to uniform appearance.
- F. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- G. Sand wood and metal surfaces lightly between coats to achieve required finish.
- H. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- I. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- J. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Refer to Section 220553 and Section 260553 for schedule of color coding of equipment, duct work, piping, and conduit.
- B. Paint shop-primed equipment, where indicated.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Finish equipment, piping, conduit, and exposed duct work in utility areas in colors according to the color coding scheme indicated.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for general requirements for field inspection.
- B. Owner reserves the right to invoke the following test procedure at any time and as often as Owner deems necessary during the period when painting is being applied.
 - 1. Owner will engage a qualified independent testing agency to sample paint material being used. Samples of material delivered to project will be taken, identified, sealed and certified in the presence of the Contractor.
 - 2. testing agency will perform appropriate tests for the following characteristics as required by Owner:
 - a. Abrasion Resistance.
 - b. Alkali Resistance.
 - c. Color Retention.
 - d. Material Content.
 - 3. Owner may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove non complying paint

from project site, pay for testing, and repaint surfaces previously coated with the non complying paint. If necessary, Contractor may be required to remove non complying paint from previously painted surface if, on repainting with specified paint, the two coatings are incompatible.

3.6 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.7 PROTECTION

- A. Protect finished coatings until completion of project.
- B. After completing painting, clean glass and paint spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.
- C. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
 - 1. After work of other trades is complete, touch-up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.8 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

END OF SECTION

SECTION 104400 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 061054 - Wood Blocking and Curbing: Wood blocking and shims.
- B. Section 099000 - Painting and Coating: Field paint finish.

1.3 REFERENCE STANDARDS

- A. NFPA 10 - Standard for Portable Fire Extinguishers; 2013.
- B. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4 PERFORMANCE REQUIREMENTS

- A. Conform to NFPA 10.
- B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers".
- B. Fire Extinguishers: Listed and labeled for type, rating and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate cabinet physical dimensions, rough-in measurements for recessed cabinets, and wall bracket mounted measurements.
- C. Product Data: Provide extinguisher operational features and color and finish.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.7 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Failure of hydrostatic test according to NFPA 10.

- b. Failure of operation of valves or release levers.
- 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. JL Industries, Inc: www.jlindustries.com.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com.
 - 3. Potter-Roemer: www.potterroemer.com.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. JL Industries, Inc: www.jlindustries.com.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com.
 - 3. Potter-Roemer: www.potterroemer.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Dry Chemical Type Fire Extinguishers (4A-80BC): Stainless steel tank, with pressure gage.
 - 1. Class A:B:C.
 - 2. Size 10.
 - 3. Finish: Baked enamel, red color.

2.3 FIRE EXTINGUISHER CABINETS

- A. Metal: Formed galvanized steel sheet; 0.036 inch thick base metal.
- B. Cabinet Configuration: Recessed type.
 - 1. Sized to accommodate accessories.
 - 2. Trim: Flat, 1 inch wide face.
 - 3. Form cabinet enclosure with right angle inside corners and seams. Form perimeter trim and door stiles.
- C. Door: 0.036 inch thick, reinforced for flatness and rigidity; latch. Hinge doors for 180 degree opening with two butt hinge. Provide nylon catch.
- D. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.
- E. Weld, fill, and grind components smooth.
- F. Finish of Cabinet Exterior Trim and Door: Primed for field paint finish.
- G. Finish of Cabinet Interior: White enamel.

2.4 ACCESSORIES

- A. Graphic Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing and location. Locate as indicated by Architect.
 - 1. Identify bracket mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

- C. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective or undercharged fire extinguishers.
- D. Proceed with installation only after satisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install fire extinguisher and cabinets plumb and level, 54 inches from finished floor to top of fire extinguisher.
- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

END OF SECTION

SECTION 123600 - COUNTERTOPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Countertops for architectural cabinetwork.

1.2 RELATED REQUIREMENTS

- A. Section 064100 - Architectural Wood Casework.

1.3 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010b.
- B. AWI/AWMAC (QSI) - Quality Standard Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2005, 8th Ed., Version 2.0.
- C. ISSFA-2 - Classification and Standards for Solid Surfacing Material; International Solid Surface Fabricators Association; 2001 (2007).
- D. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- E. PS 1 - Structural Plywood; 2007.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- D. Selection Samples: Submit five samples for each finish product specified, color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: Submit five samples for each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- F. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- G. Installation Instructions: Manufacturer's installation instructions and recommendations.
- H. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Same fabricator as for cabinets on which tops are to be installed.
- B. Installer Qualifications: Fabricator.
- C. Fire Test Response Characteristics: Provide original fire test reports to ensure compliance with the following requirements:

1. Burn Rate: ASTM D635, Class CC1, for a nominal thickness of 1.5 mm.
 2. Self-Ignition Temperature: ASTM D1929, greater than 650 degrees F.
 3. Smoke Density: ASTM D2848, less than 78%.
 4. Flammability Classification: ASTM E-84, smoke less than 450; flame spread less than 75.
- D. Impact Resistance: Provide Solid Surfacing Countertops that comply with the following requirements:
1. Impact Strength: Un-notched (23 deg.), ASTM D4812: No breakage.
 2. Impact Strength, Notched: (23 deg.), ASTM D526: 88J/m (1/16).
- E. Allowable Tolerances:
1. Maximum Deflection: 1/16" over 12".

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

- A. Manufacturer's Special Warranty on Solid Surfacing Countertops: Manufacturer's standard form agreeing to repair or replace units that fail in material or workmanship within the specified warranty period.
- B. Warranty Period: 1 year after the date of Substantial Completion.
- C. The warranty shall not deprive the Owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 COUNTERTOP ASSEMBLIES

- A. Plastic Laminate Countertops: High pressure decorative laminate sheet bonded to substrate.
1. Laminate Sheet, Unless Otherwise Indicated: NEMA LD 3 Grade HGS, 0.048 inch nominal thickness.
 - a. Surface Burning Characteristics: Flame spread 25, maximum; smoke developed 450, maximum; when tested in accordance with ASTM E84.
 - b. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
 - c. Laminate Core Color: Same as decorative surface.
 - d. Finish: Matte or suede, gloss rating of 5 to 20.
 - e. Surface Color and Pattern: To be selected from manufacturer's full line.
 - f. Basis of Design Manufacturers:
 - 1) Abet Laminati: www.abetlaminati.com.
 - 2) Lamin-Art: www.laminart.com.
 - g. Other Acceptable Manufacturers:
 - 1) Formica Corporation: www.formica.com.

- 2) Panolam Industries International, Inc\Nevamar: www.nevamar.com.
 - 3) Wilsonart International, Inc: www.wilsonart.com.
 - h. Substitutions: See Section 016000 - Product Requirements.
 2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch thick; covered with matching laminate.
 3. Back and End Splashes: Same material, same construction.
 4. Fabricate in accordance with AWI/AWMAC Quality Standards Illustrated Premium Grade.
- B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
1. Basis of Design Product: The design of Solid Surfacing Countertops as manufactured by Corian.
 - a. Flat Sheet Thickness: 1/2 inch, minimum.
 - b. Sheet Size: Maximum 4' x 8', or 4' x 10'.
 - c. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISSFA-2 and NEMA LD 3; polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - 1) Surface Burning Characteristics: Flame spread 25, maximum; smoke developed 450, maximum; when tested in accordance with ASTM E84.
 - 2) Finish on Exposed Surfaces: Semi-gloss, gloss rating of 25 to 50.
 - d. Color and Pattern: As indicated on drawings.
 - e. Other Acceptable Manufacturers:
 - 1) Schober, Inc.; Product: Lumicor; www.schober.com.
 - 2) Dupont: www.corian.com.
 - 3) Formica Corporation: www.formica.com.
 - 4) Avonite Surfaces: www.avonitesurfaces.com.
 - 5) Wilsonart International, Inc: www.wilsonart.com.
 - 6) Substitutions: See Section 016000 - Product Requirements.
 - f. Other Components Thickness: 1/2 inch, minimum.
 - g. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; edge profile as indicated on drawings.
 - h. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.

2.2 ACCESSORY MATERIALS

- A. Wood-Based Components:
1. Wood fabricated from old growth timber is not permitted.
 2. Provide sustainably harvested wood, certified or labeled as specified in Section 016000.
- B. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- D. Joint Sealant: Mildew-resistant silicone sealant, Color as selected by Architect from manufacturer's full range..

2.3 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
 - 1. Acceptable means of machining are listed below. Ensure that material is not chipped or warped by machining operations.
 - a. Sawing: Select equipment and blades suitable for type of cut required.
 - b. Drilling: Drills especially designed for use with plastic products.
 - c. Milling: Climb cut where possible.
 - d. Routing.
 - e. Tapping.
 - f. Shearing and Punching: Acceptable only on 1/16" materials.
 - g. Die Cutting: Acceptable only on material 1/8" or less.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install countertops as recommended by the manufacturer's written instructions.
- B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- C. Utilize fasteners, adhesives, and bonding agents recommended by the manufacturer for type of installation indicated. Material that is chipped, warped, hazed or discolored as a result of installation or fabrication method will be rejected.
- D. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- E. Attach solid surface countertops to substrate as recommended by the solid surface manufacturer's written instructions.
- F. Seal joint between back/end splashes and vertical surfaces.

3.4 CLEANING AND PROTECTION

- A. Clean countertops surfaces thoroughly.

- B. Protect installed products until completion of project.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 125111 - MODULAR CASEWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Modular mail receiving, sorting and distribution casework.

1.2 RELATED REQUIREMENTS

- A. Section 079005 - Joint Sealers.

1.3 REFERENCES

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2013a.
- B. NEMA LD 3 - High Pressure Decorative Laminates.
- C. PS 1 - Structural Plywood; 2009.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Complete, detailed layout with model numbers and complete dimensioning information for installation.
- D. Selection Samples: For each finish product specified, five complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches square, representing actual product, color, and patterns.
- F. Maintenance Data: Ordering information on optional components.
- G. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer Qualifications: Company specializing in performing work of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver equipment until spaces where it is to be installed are complete and cleaned.
- B. Store products in manufacturer's unopened packaging until ready for installation.

1.7 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

- A. Manufacturer's limited lifetime warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Hamilton Sorter: www.hamiltonsorter.com.
- B. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Particleboard: Industrial grade, 40 to 50 pcf, substrate.
- B. High Pressure Plastic Laminate: NEMA LD 3 as manufactured by WilsonArt, Pionite, Nevamar or Formica.
- C. High Pressure Melamine Laminate: NEMA LD 3 as manufactured by WilsonArt, Pionite, Nevamar or Formica.
- D. Marmoleum Linoleum Sheet that provides a self-sanitizing bactericidal resistant quality.

2.3 MAILROOM FURNITURE COMPONENTS

- A. Provide Hamilton Sorter "Mail Center and Communications Furniture" series components, fully modular and reconfigurable.
 - 1. Select type and size of units and accessories to provide the functionality indicated on the Drawings.
- B. Sort Modules: Thermally fused laminate on core particle board; 1 inch thick vertical ends and 5/8 inch thick top, bottom, and interior partitions; concealed fasteners; locking to console frame.
 - 1. Sort module size configuration as indicated on the Drawings.
 - a. Standard size: 10-13/16 by 11-3/4 inches deep shelves.
 - 2. Fit each vertical section with full depth injection molded rigid PVC plastic shelf supports, at 1 inch on center.
 - 3. Adjustable Polyethylene Shelving: Removable and interchangeable polyethylene shelves of 1/8 inch polyethylene with memory retention, with full width aluminum indexing support channel front and back, rated capacity of minimum of 35 pounds; manufacturer's standard quantity for unit size.
 - 4. Indexing channels covered with removable clear plastic cover, holding paper index strips.
- C. Freestanding Modules: Same construction and finish as sort modules, with feet for floor installation.
 - 1. Sort module size configuration as indicated on the Drawings.
 - a. Standard size: 10-13/16 by 11-3/4 inches deep shelves.

2.4 FABRICATION

- A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.
- B. Fabricate corners and joints without gaps or inaccessible spaces or areas where dirt or moisture could accumulate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until spaces to receive furniture have been completed and cleaned.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install furniture and accessories as indicated on drawings, level and plumb, with separate units securely anchored.
- C. Adjust legs to height required.
- D. Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly.
- E. Clean casework, counters, shelves, legs, hardware, fittings and fixtures.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Do not permit finished casework to be exposed to continued construction activity.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Sprinklers.
 - 3. Pressure gages.
- B. Related Sections:

1.2 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Floors undergoing renovation with existing sprinkler systems may be designed per the NFPA pipe schedule method. Full areas currently without existing sprinkler systems shall be hydraulically designed. Design these sprinkler systems using performance requirements and design criteria indicated.
 - 1. Use the most recent fire pump flow test records available from the building engineer's files.
- C. The sprinkler contractor shall reconfigure the existing wet sprinkler system to provide full sprinkler protection for the entire renovated floor. Full sprinkler protection means that the automatic sprinkler systems shall be installed throughout the space in accordance with the requirements of the International Building Code-2012 and NFPA 13-2013 and include proper protection of any space that is currently not protected. This may include, but is not limited to electrical room, mechanical spaces, janitor's closets, coat closets, etcetera.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 - 3. Maximum Protection Area per Sprinkler:
 - a. Office Spaces: 225 sq. ft. (20.9 sq. m).
 - b. Storage Areas: 130 sq. ft. (12.1 sq. m).
 - c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
 - d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
 - 4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm (6.3 L/s).

b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s).

- E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: The sprinkler contractor shall submit sprinkler RCP plans that are coordinated with lights, diffusers, walls, speakers, and fire alarm devices for review and approval by the Architect prior to installation.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and professional engineer.
- B. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.
- D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13-2013, "Installation of Sprinkler Systems."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Thinwall, Black Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- C. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Uncoated, Steel Couplings: ASTM A 865, threaded.
- E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Corcoran Piping System Co.
 - c. National Fittings, Inc.
 - d. Shurjoint Piping Products.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
 - 2. Pressure Rating: 175 psig (1200 kPa) minimum or 300 psig (2070 kPa) as required.
 - 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- K. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig (1200-kPa) pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Victaulic Company.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Shurjoint Piping Products.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
 - 2. Standard: UL 213.
 - 3. Pressure Rating: 175 psig (1200 kPa) minimum or 300 psig (2070 kPa) as required.
 - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 5. Type: Mechanical-T and -cross fittings.
 - 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Adjustable Drop Nipples:
 - 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CECA, LLC.
 - b. Corcoran Piping System Co.
 - c. Merit Manufacturing; a division of Anvil International, Inc.
 - 2. Standard: UL 1474.
 - 3. Pressure Rating: 250 psig (1725 kPa) minimum or 300 psig (2070 kPa) as required.
 - 4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - 5. Size: Same as connected piping.
 - 6. Length: Adjustable.
 - 7. Inlet and Outlet: Threaded.
- C. Flexible, Sprinkler Hose Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fivalco Inc.
 - b. FlexHead Industries, Inc.
 - c. Gateway Tubing, Inc.
 - 2. Standard: UL 1474.
 - 3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
 - 4. Pressure Rating: 175 psig (1200 kPa) minimum or 300 psig (2070 kPa) as required.
 - 5. Size: Same as connected piping, for sprinkler.

2.5 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFAC Inc.
 - 2. Globe Fire Sprinkler Corporation.
 - 3. Reliable Automatic Sprinkler Co., Inc.
 - 4. Tyco Fire & Building Products LP.
 - 5. Venus Fire Protection Ltd.
 - 6. Victaulic Company.
 - 7. Viking Corporation.
- B. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
 - 3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum or 300 psig (2070 kPa) as required.
- C. Automatic Sprinklers with Heat-Responsive Element:
 - 1. Nonresidential Applications: UL 199.
 - 2. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Finishes:
 - 1. Chrome plated.
 - 2. Bronze.
 - 3. Painted.
- E. Special Coatings:
 - 1. Wax.
 - 2. Corrosion-resistant paint.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Plastic, white finish, one piece, flat.
 - 2. Sidewall Mounting: Plastic, white finish, one piece, flat.
- G. Sprinkler Guards:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 - 2. Standard: UL 199.
 - 3. Type: Wire cage with fastening device for attaching to sprinkler.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- H. Refill sprinkler system piping with water. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace any sprinklers that are painted other than with a factory finish.

3.8 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.

3. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 4. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 5. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 6. Thinwall black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
 7. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6 (DN 65 to DN 150), shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 4. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 5. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.

3.9 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Recessed sprinklers.
 3. Wall Mounting: Sidewall sprinklers.
 4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as required.
 5. Special Applications: Quick-response sprinklers except where indicated otherwise.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 2. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Escutcheons.
4. Plumbing demolition.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

1.3 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- D. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic hot-water piping.
 - 2. Supplies and drains for handicap-accessible lavatories and sinks.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 2. Detail removable insulation at piping specialties, equipment connections, and access panels.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- C. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000-Degree Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket.
- D. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armacell LLC; Tubolit.
 - b. Nomaco Insulation; IMCOLOCK and NOMALOCK.

2.2 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Engineered Brass Company.
 - b. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing.
 - d. Plumberex.
 - e. Truebro; a brand of IPS Corporation.
 - f. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation.

3.2 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings and Short Pipes:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

3.3 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.4 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.5 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.8 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Hot Water: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 3/4 inch (19 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 3. Polyolefin: 3/4 inch (19 mm) thick.
- B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1/2 inch (13 mm) thick.
 - 2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 3. Polyolefin: 1/2 inch (13 mm) thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

1.2 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.

3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:

1. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys.
- B. Flux: ASTM B 813, water flushable.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. Jomar International.
 - e. Matco-Norca.
 - f. McDonald, A. Y. Mfg. Co.
 - g. Watts; a division of Watts Water Technologies, Inc.
 - h. Wilkins; a Zurn company.
 3. Standard: ASSE 1079.
 4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 5. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Nipples:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products; Tyco Fire Products LP.
 - c. Matco-Norca.

- d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
-
- 3. Standard: IAPMO PS 66.
 - 4. Electroplated steel nipple complying with ASTM F 1545.
 - 5. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - 6. End Connections: Male threaded or grooved.
 - 7. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install shutoff valve immediately upstream of each dielectric fitting.
- C. Install water-pressure-reducing valves downstream from shutoff valves where the system pressure exceeds 75 psi.
- D. Install domestic water piping level and plumb.
- E. Install seismic restraints on piping as required by local code.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in ASCE/SEI 7.
- B. Comply with requirements for pipe hanger, support products, and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.

- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
- F. Install supports for vertical copper tubing every 10 feet (3 m).
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
- H. Install supports for vertical steel piping every 15 feet (4.5 m).

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated via a single cold water stop.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.7 IDENTIFICATION

- A. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

- 1. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

- a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
 - 1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) ASTM B 88, Type M (ASTM B 88M, Type C); cast or wrought copper, solder-joint fittings; and brazed soldered joints.
 - 2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) or ASTM B 88, Type M (ASTM B 88M, Type C); copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 3. Soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) or ASTM B 88, Type M (ASTM B 88M, Type C); compression fittings.

END OF SECTION 221116

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Matco-Norca, Inc.
 - e. MIFAB, Inc.
 - f. Mission Rubber Company; a division of MCP Industries, Inc.
 - g. Stant.
 - h. Tyler Pipe.
2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company; a division of MCP Industries, Inc.
 - 4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- D. Install piping at indicated slopes.

- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in ASCE/SEI 7.
- H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- I. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- J. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- K. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded, nonpressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in ASCE/SEI 7.
- B. Comply with requirements for pipe hanger and support devices and installation specified below:
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to existing sanitary building sewerage piping. Use transition fitting to join dissimilar piping materials.

- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI or heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Electric, tankless, domestic-water heaters.

1.2 PERFORMANCE REQUIREMENTS

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power.

1.4 INFORMATIONAL SUBMITTALS

- A. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.
 - a. Electric, Tankless, Domestic-Water Heaters: One year.

PART 2 - PRODUCTS

2.1 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
2. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Bosch Water Heating.
 - b. Chronomite Laboratories, Inc.
 - c. E-Tankless Water Heaters Corp.
 - d. Keltech, Inc.
 - e. Niagara Industries, Inc.
3. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
4. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Connections: Compression.
 - b. Pressure Rating: 150 psig (1035 kPa).
 - c. Heating Element: Resistance heating system.
 - d. Safety Control: Faucet flow control.
 - e. Jacket: Aluminum or steel with enameled finish or plastic.
5. Support: Bracket for wall mounting.
6. Capacity and Characteristics:
 - a. Flow Rate: 0.5 gpm at 57 deg F temperature rise.
 - b. Power Demand: 4,100W.
 - c. Electrical Characteristics:
 - 1) Volts: 208.
 - 2) Phases: Single.
 - 3) Hertz: 60.
 - 4) Breaker Size: 20A.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 12 inches above floor on the wall.

1. Maintain manufacturer's recommended clearances.
 2. Arrange units so devices that require servicing are accessible.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for sinks.
 - 2. Laminar-flow faucet-spout outlets.
 - 3. Kitchen sinks.
- B. Related Sections include the following:
 - 1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
 - 2. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act";] for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Stainless-Steel Residential Sinks: ASME A112.19.3.
- H. Comply with the following applicable standards and other requirements specified for sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 6. Hose-Coupling Threads: ASME B1.20.7.
 - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 8. NSF Potable-Water Materials: NSF 61.
 - 9. Pipe Threads: ASME B1.20.1.
 - 10. Supply Fittings: ASME A112.18.1.
 - 11. Brass Waste Fittings: ASME A112.18.2.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

- A. Furnish and install all plumbing fixtures complete with all equipment, fittings, trim and accessories as required for a complete installation.
- B. All fixtures shall be Grade A. The name and trademark of the manufacturer shall be printed or pressed on all closets and lavatories. All fixtures shall be thoroughly cleaned after installation.
- C. Fixture Schedule:

- 1. F-1

Sink, Stainless Steel, Manual Faucet, Handicapped Accessible:

Single compartment, 18 gauge stainless steel: Elkay LRAD2222, 6½" deep with off-centered rear outlet.

Faucet shall be Elkay Model LKE4123 with single lever, gooseneck faucet and hose spray. Provide with 1.5 gpm aerator.

Sink Drain shall be Elkay LK18 stainless steel drain fitting with perforated 3" grid strainer. Provide 1½" offset tailpiece by Elkay, American Standard, Brass Craft or McGuire.

Trap shall be 1½", 17 gauge adjustable "P" traps with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

Stops shall be angle type ½ inch copper sweat extension tube inlet x ¾ inch O.D. compression risers and loose key, lock shield. Risers shall be flexible copper one-piece with insert. Exposed surfaces shall be chrome plated. Provide bell escutcheon at wall. Brass Craft CS400A-S or McGuire 170 LK, EBC LA26K or Watts B892120CLK.

- 2. F-2

Recessed Valve Box: Water Tite 9000 w/ valve installed Oatley 38680

- 3. F-3

Electric Water Cooler (Single Level):

Wall mounted, stainless steel finish, push button actuated, 8.0 GPH of 50 deg. F water at 90 deg. F ambient air temperature. Cooler: Oasis P8AM. Other approved manufacturers: Halsey Taylor, Elkay, Haws, Sunroc

Trap shall be 1 ¼", 17 gauge adjustable "P" traps with cleanout and wall plate. Exposed surfaces shall be polished chrome. Manufacturers: Brass Craft, McGuire, EBC or Watts.

- D. Plumbing Fixtures Notes:

1. Approved manufacturers for plumbing fixtures: Kohler, American Standard, TOTO, Crane, Eljer, Elkay, Just, Bradley, Acorn, or as specified in the schedule above

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install fixtures level and plumb according to roughing-in drawings.
- F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- I. Install trap-seal liquid in dry urinals.
- J. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- K. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

- L. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- M. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- N. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
- O. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- P. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Operate and adjust hot-water dispensers. Replace damaged and malfunctioning units.
- C. Adjust water pressure at faucets to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 224716 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pressure water coolers and related components.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
- B. Shop Drawings: Include diagrams for power wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers Wall Mounted, wheelchair accessible.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
 - a. Tri Palm International, LLC; Oasis Brand.
 - b. Tri Palm International, LLC; Sunroc Brand.
 - 3. Standards:
 - a. Comply with NSF 61.
 - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
 - 4. Cabinet: Steel with powder-coat finish.
 - 5. Bubbler: One, with adjustable stream regulator, located on deck.
 - 6. Control: Push button.
 - 7. Drain: Grid with NPS 1-1/4 (DN 32) tailpiece.
 - 8. Supply: NPS 3/8 (DN 10) with shutoff valve.
 - 9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
 - 10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

11. Cooling System: Electric, with[precooler,] hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
12. Capacities and Characteristics:
 - a. Cooled Water: 8 gph (0.0084 L/s)].
 - b. Ambient-Air Temperature: 90 deg F (32 deg C).
 - c. Inlet-Water Temperature: 80 deg F (27 deg C).
 - d. Cooled-Water Temperature: 50 deg F (10 deg C).
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/4.
 - 2) Volts: 120-V ac.
 - 3) Phase: Single.
 - 4) Hertz: 60.
 - 5) Full-Load Amperes: 4.6.
13. Support: ASME A112.6.1M, Type I water-cooler carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.
- D. Install new trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.

- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Division 22 Section "Domestic Water Piping."
- C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler.
- D. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

- A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224716

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Concrete bases.
10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 1. CPVC Piping: ASTM F 493.
 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.5 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: **Polished chrome-plated.**
- C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: **Polished chrome-plated.**

2.6 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 7. Use **3000-psi**, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "**Cast-in-Place Concrete**."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium Efficiency, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class H.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers:
 - 1. Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 3. Inverter Duty Motors: Class B temperature rise; Class H insulation
 - 4. AEGIS SGR Bearing Protection Ring: Install a maintenance free, circumferential, conductive micro fiber shaft grounding ring (AEGIS™ SGR) on the AC motor to discharge shaft currents to ground.
 - 5. Conductive Shaft Surface Coating: Engineered silver flake < 1µm flake.

2.5 SINGLE-PHASE MOTORS

- A. Motors smaller than 1/2 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Electronically Commutated Motor
- B. Permanent-split-capacitor multispeed motors:
 - 1. Variable-torque, type.
 - 2. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - 3. Motors 1/20 HP and Smaller: Shaded-pole type.
 - 4. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- C. Electronically Commutated Motors:
 - 1. Motors shall be General Electric ECM variable speed brushless DC motors specifically designed for use with a single phase, 277 volt, 60 Hertz electrical input.
 - 2. Motor shall be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commute the stator.
 - 3. All motors shall be designed for synchronous rotation. Motor rotor shall be permanent magnet type with near zero rotor losses. Motor shall have built-in soft start and slewed speed change ramps.
 - 4. Motor shall be able to be mounted with shaft in horizontal or vertical orientation. Motor shall be permanently lubricated with ball bearings. Motor shall be direct coupled to the blower.
 - 5. Motor shall maintain a minimum of 65% efficiency over its entire operating range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in partitions.
- B. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- C. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-sheet sleeves

END OF SECTION 23 05 17

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Flow Measuring Balancing and Shutoff Valve (FMBV)
- 2. Bronze ball valves.
- 3. Test Plugs
- 4. Test Plug Accessories
- 5. Butterfly Valves
- 6. Swing Check Valves
- 7. Check Valves at Pumps
- 8. Strainers
- 9. Pressure Cages
- 10. Air/Dirt Separators
- 11. Automatic Air Vents

- B. Related Sections:

- 1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
- 2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve or specialty indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Handlever: For quarter-turn valves NPS 6 and smaller.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Flow Measuring Balancing and Shutoff Valve (FMBV): With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- F. Valve-End Connections:
1. Solder Joint: With sockets according to ASME B16.18.
 2. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 FLOW MEASURING BALANCING AND SHUTOFF VALVE (FMBV)

- A. 4" and Smaller:
1. Manufacturers:
 - a. Tour Anderson.
 - b. Nibco Figure 1710
 - c. Mepco Model MBV.
 - d. Armstrong ABV
 2. Description and features:

- a. Calibrated port.
 - b. Shut-off valve.
 - c. Gage connections with integral check valves.
 - d. Multi-turn handwheel. Quarter-turn valve not acceptable.
 - e. Valve position indicator.
 - f. Memory stop (allows shut off and return to set position without measurement).
3. Body material: Bronze, bronze alloy or dezincification brass.
4. Rating:
 - a. Sweat connection: 200 psig at 250 deg F.
 - b. Threaded: 400 psig at 250 deg F.
 - c. Flanged: 175 psig at 250 deg F.
5. Maximum pressure drop (with valve wide open) : 1 psig at design flow.
6. Insulation:
 - a. Provide molded insulation sized to match valve when used in chilled water system.

2.3 BRONZE BALL VALVES

A. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. DynaQuip Controls.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Red-White Valve Corporation.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.4 TEST PLUGS

A. Manufacturers: Flow Design, Inc. Superseal; Peterson Engineering, Sisco, Trerice, Universal Lanchester.

- B. Description: Plug suitable to accept 1/8 " diameter thermometer stem or pressure gauge adapter. Plug 1/4" male pipe thread by 2-3/4" long. Plug for uninsulated pipe shall be 1/4" male pipe thread by 1/4" long.
- C. Material: Brass body with dual Nordel seals, brass cap and cap retainer strap.
- D. Rating 1000 psi at 270 deg F.
- E. Accessories: Furnish pressure gauge adapters with probe, two pressure gauges and two 1" (min.) dia. dial thermometers matched with the test plugs. Furnish a tool box case with foam plastic cushion liner and a tube of silicon lubricant.

2.5 BUTTERFLY VALVES

- A. Description:
 - 1. Body material: Cast iron.
 - 2. CWP rating: 200 psig.
 - 3. Body configuration: Tapped lugs (suitable for drop-tight shutoff for end-of-line service with the downstream flange), extended neck.
 - 4. Body material: ASTM A126, cast iron or ASTM A 536, ductile iron
 - 5. Disc material: stainless steel.
 - 6. Stem: Stainless steel.
 - 7. Seat: NBR.
 - 8. Operator: hand lever

2.6 SWING CHECK VALVES

- A. Description:
 - 1. Standard: MSS SP-71, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Clear or full waterway.
 - 4. Body Material: ASTM A 126, gray iron with bolted bonnet
 - 5. Ends: Flanged.
 - 6. Trim: Bronze.
 - 7. Gasket: asbestos free.

2.7 CHECK VALVES AT PUMPS

- A. Manufacturers:
 - 1. APCO Series 6000.
 - 2. CPV.
 - 3. Metraflex.
 - 4. Mueller-MUESSCO #105AP and 203BP,
 - 5. Nibco F910B and T480,
 - 6. Combination Pump Valve Co. 20B.
- B. Description: Class 150, iron, globe, center-guided check Valves with metal seat, non-slam, counterweighted or spring loaded.

1. Standard: MSS SP-125.
2. CWP Rating: 200 psig.
3. Style: globe, spring loaded.
4. Body Material: ASTM A 126 cast iron or ASTM A 536, ductile iron
5. Ends: Flanged.
6. Disc: bronze or cast iron
7. Seat: Bronze.
8. Spring (if used): stainless steel

2.8 STRAINERS

- A. Description: Wye or "Y" style with threaded cap or flange for screen access.
1. Material: Cast iron, ductile iron, or cast steel.
 2. CWP Rating: 200 psig
- B. Acceptable Screen Material, type and size: brass, monel, or stainless steel; perforated sheet metal screens with 3/64-inch- diameter holes
- C. Blowdown: 1/2-inch shutoff valve with 3/4" capped hose end connection and chain

2.9 PRESSURE GAGES

- A. Description:
1. Bronze movement.
 2. Minimum accuracy: 1 percent.
 3. Nonferrous case with blowout back.
 4. Maximum and minimum stops.
 5. 4-1/2-inch dial face.
- B. Accessories: provide 250 psi quarter turn brass gage cocks
- C. Range: 0-160 psi.

2.10 AIR/DIRT SEPARATOR

- A. Manufacturer: Spirotherm "Spirovent"
- B. Description: full flow coalescing type combination air eliminator and dirt separator, with include two equal chambers above and below the inlet / outlet nozzles.
- C. Construction: fabricated steel, rated for 150 psig working pressure, registered for unfired pressure vessels under the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, complete with a National Board stamp.
1. Provide a removable lower head for internal inspection.
 2. Provide a valved side tap.
- D. Elements: internal spirotube elements filling the entire vessel with no open space between them. The elements shall consist of a copper core tube with continuous wound copper medium

permanently affixed to the core. A separate copper medium shall wind completely around and permanently affixed to the internal element.

- E. Air elimination performance: air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installation location.
- F. Dirt separation performance: dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes.

2.11 AUTOMATIC AIR VENT

- A. Manufacturer: Spirotherm "Spirotop"
- B. Description: Cast Brass, Designed for use on high pressure systems.
 - 1. Maximum Pressure Rating: Exceed maximum pressure rating of system and not less than 150 psig.
 - 2. Maximum Temperature Rating: Exceed maximum temperature rating of system and not less than 270 degrees F.
 - 3. Inlet: 1/2" FPT.
 - 4. Outlet: 1/2" MPT

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

- E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball valves for piping NPS 2 and smaller; butterfly valves for piping larger than NPS 2.
 2. Flow Measuring Balancing Service: Flow measuring, balancing valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Solder-joint valve-end option.
- D. Install all flow measuring balancing and shutoff valves in accordance with the manufacturer's recommendations with the necessary straight pipe on the upstream and downstream of the valve.
- E. Install manual air vents at the high points of each piping system.
- F. Install automatic air vents where shown on drawings and at the top of each closed piping system.
- G. Air vent outlets shall be connected to 1/2 inch 3/8 inch copper tubing routed to accessible location.
- H. Install all air vents in easily accessible areas.
- I. Provide Needle Valve at each manual air vent bleed point.
- J. Provide nipples and couplings to make the test plugs, thermometer and gauges extend through the insulated pipe.
- K. Mount thermometers and pressure gages to be read by a person standing on the floor.
- L. Provide snubber at each pressure gauge.
- M. Provide Gauge Cock for isolation at each pressure gauge

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Three piece, full port, bronze with bronze trim.

3.6 SECONDARY WATER SYSTEM AND DRAINAGE SYSTEM VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, stainless-steel disc.
2. Iron Swing Check Valves: Class 250, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 150, lever and spring or weight.
4. Iron, Center-Guided Check Valves: Class 150, globe, metal seat.

END OF SECTION 23 05 23

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

- B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
4. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless-] steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- F. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

- G. Install lateral bracing with pipe hangers and supports to prevent swaying.
- H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Copper Clevis Hangers (MSS Type 1): For suspension of noninsulated stationary pipes NPS 1/2 to NPS 2.
- F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 - 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- H. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- I. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- J. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following: Adjust list below to suit Project.

- 1. Elastomeric hangers.
- 2. Spring hangers.
- 3. Spring hangers with vertical-limit stops.
- 4. Restraining braces and cables.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: 6.0.
 - c. Component Amplification Factor: 2.5.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 15%.
 - 4. Design Spectral Response Acceleration at 1-Second Period: 6%.

1.5 ACTION SUBMITTALS

- A. Product Data for the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

- a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
- b. Annotate to indicate application of each product submitted and compliance with requirements.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- E. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Ace Mountings Co., Inc.
 2. Amber/Booth Company, Inc.
 3. California Dynamics Corporation.
 4. Isolation Technology, Inc.
 5. Kinetics Noise Control.
 6. Mason Industries.
 7. Vibration Eliminator Co., Inc.
 8. Vibration Isolation.
 9. Vibration Mountings & Controls, Inc.
- B. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- C. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- D. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti, Inc.
 5. Kinetics Noise Control.
 6. Loos & Co.; Cableware Division.
 7. Mason Industries.
 8. TOLCO Incorporated; a brand of NIBCO INC.
 9. Unistrut; Tyco International, Ltd.
- B. Restraint Cables: ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel or powder coat for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- B. Install cables so they do not bend across edges of adjacent equipment or building structure.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Test at least four of each type and size of installed anchors and fasteners.
 - 3. Test to 90 percent of rated proof load of device.
 - 4. Measure isolator restraint clearance.
 - 5. Measure isolator deflection.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust active height of spring isolators.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Duct labels.
 - 4. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 3 by 1 inch.
 6. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.3 DUCT LABELS

- A. Color coded self adhesive duct markers include a die cut or detachable directional arrow
- B. Letter Color: White.
- C. Background Color: Blue, yellow or green
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 16 x 2-1/4".
- F. Minimum Letter Size: 1 inch.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible
- C. Provide Bakelite nameplates on all equipment, motor starters, remote push button stations, insertion type thermostats, remote bulb thermometers, filter gauges, pump pressure gauges, fans, pumps, panel mounted controls and manual damper operators, multi-zone damper sections by room number, room designation, zone number, etc.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of [50 feet (15 m)] <Insert dimension> along each run. Reduce intervals to [25 feet (7.6 m)] <Insert dimension> in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Condenser-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
2. Refrigerant Piping:
 - a. Background Color: Yellow
 - b. Letter Color: Black
3. Condensate Drain Piping:
 - a. Background Color: Green
 - b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 1. Green: For cold-air supply ducts.
 2. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 3. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape: 1-1/2 inches round
 2. Valve-Tag Color: Natural
 3. Letter Color: Black

END OF SECTION 23 05 53

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Scope of Work Includes:

1. Prior to construction to document existing conditions, measure existing air and water systems:
 - a. AC-1, AC-2, and R-1 in the mechanical penthouse, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - b. AC-3, AC-4, and R-2 on the CR Level, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - c. AC-5, AC-6, and R-4 on the SB Level, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - d. Pumps P-6 and P-7 in the mechanical penthouse, flow and total dynamic head, motor amp draw, voltage, motor speed, pump speed
 - e. Pumps P-9 and P-10 on the CR Level, flow and total dynamic head, motor amp draw, voltage, motor speed, pump speed
 - f. Induction units floors 7, 22, 23, 24, static pressure only
 - g. Traverse supply, return and toilet exhaust air flow at each of floors 7, 22, 23, 24.
 - h. Submit report of findings to Engineer within one month of award of contract.
2. Test adjust and balance after retro fit with VFD:
 - a. AC-1, AC-2 and R-1 in the mechanical penthouse, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - b. AC-3, AC-4, and R-2 on the CR Level, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - c. AC-5, AC-6, and R-4 on the SB Level, OA, RA and SA flow, static pressures, motor amp draw, voltage, motor speed, fan speed
 - d. Pumps P-6 and P-7 in the mechanical penthouse, flow and total dynamic head, motor amp draw, voltage, motor speed, pump speed
 - e. Pumps P-9 and P-10 on the CR Level, flow and total dynamic head, motor amp draw, voltage, motor speed, pump speed
3. See Fans & Drives schedule, sheet MM601, for additional instructions.
4. Test adjust and balance:
 - a. New WSHP systems including diffusers, on floors 7, 22, 23, 24.
 - b. New VAV terminal units including diffusers, on floors 7, 22, 23, 24.
 - c. Existing core air distribution devices including diffusers, grilles and registers on floors 7, 22, 23, 24.
 - d. Traverse supply, return and toilet exhaust air flow at each of floors 7, 22, 23, 24 after VAV retrofit.
 - e. Inductions units on floors 7, 22, 23, 24.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- C. Certified TAB reports.
- D. Sample report forms.
- E. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
- B. TAB Conference: Meet with Commissioning Authority for approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by AABC or NEBB.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents and Existing As-Built Drawings to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased and equipment with functioning controls is ready for operation.

- J. Examine terminal variable-air-volume terminal units, and verify that they are accessible and their controls are connected and functioning.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Hydronic systems (WSHP only) are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.
 - 4. Equipment and duct access doors are securely closed.
 - 5. Balance, smoke, and fire dampers are open.
 - 6. Isolating and balancing valves are open and control valves are operational.
 - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and/or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PRE-CONSTRUCTION PROCEDURES FOR MEASURING INDUCTION-UNIT SYSTEMS

- A. Measure and report primary air static pressure and compare to manufacturers rated value. Report measured static and airflow (manufacturers rating based on measured static) at each induction unit.
- B. Measure and report entering and leaving water temperature at each unit in full cooling.
- C. Document position of manual dampers as found.

3.6 PROCEDURES FOR T&B OF INDUCTION-UNIT SYSTEMS

- A. After units are cleaned, measure and report primary air static pressure and compare to manufacturers rated value. Report measured static and airflow (manufacturers rating based on measured static) at each induction unit.
- B. Measure and report entering and leaving water temperature and entering and leaving air temperature at each unit in full cooling and full heating mode. Report calculated gpm based on air temperatures.
- C. Document position of manual dampers as balanced.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts using design drawings.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.
 - 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.11 PROCEDURES FOR PRE-CONSTRUCTION TESTING OF EXISTING SYSTEMS

A. Scope is defined in Part 1.

B. Perform a preconstruction test (measurement only) and inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and pressures.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Energize heaters, note operation and measure operating conditions
4. Note the condition of filters.
5. Note the condition of coils.
6. Note the operation of the drain pan and condensate-drain trap.
7. Note condition of bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken in report with original design criteria.
9. Report deficiencies or major differences between design and measured. Compare the values to original design information (Drawings MM601 and 602)

3.12 PROCEDURES FOR TESTING ADJUSTING AND BALANCING OF EXISTING SYSTEMS

- A. Scope is defined in Part 1
- B. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.

3.13 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.

- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in CFM.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in CFM.
 - j. Return airflow in CFM.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
 - 1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft.
 - h. Tube size in NPS
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in CFM.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F
 - e. Return-air, wet- and dry-bulb temperatures in deg F
 - f. Entering-air, wet- and dry-bulb temperatures in deg F
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F
 - k. Leaving-water temperature in deg F
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F
 - o. Inlet steam pressure in psig.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:

- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in CFM.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in CFM.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in CFM.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- I. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.

- h. Size.
 - i. Effective area in sq. ft.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in CFM.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in CFM.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in CFM.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
- 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flow meter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in CFM.
 - b. Entering-water temperature in deg F
 - c. Leaving-water temperature in deg F
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F
 - f. Leaving-air temperature in deg F
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Peak Season: Perform both near-peak summer and near peak winter conditions.

END OF SECTION 23 05 93

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply air.
- B. Related Sections:
 - 1. Division 23 Section "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having

jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.

- e. Owens Corning; SOFTR All-Service Duct Wrap.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 5. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: Aluminum.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

- A. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - e. <Insert manufacturer's name; product name or designation>.
2. Width: 4 inches.
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

- A. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

- a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.

- B. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.9 CORNER ANGLES

- A. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches (50 mm)] [4 inches (100 mm)] o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):
 - 1. Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.

8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION 23 07 13

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.

- B. Related Sections:

1. Division 23 Section "Duct Insulation."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-38.
 - b. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 7. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of union.
 3. Construct removable valve insulation covers in same manner as for unions, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: White. Vary first and second coats to allow visual inspection of the completed Work.

3.7 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Underground piping.
 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.8 PIPING INSULATION SCHEDULE

- A. Condensate drain: Insulation shall be one of the following:
 1. Flexible Elastomeric: 1/2 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric 1 inch thick.

- C. Refrigerant Suction and Hot-Gas Flexible Tubing: Flexible elastomeric 1 inch thick.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Division 01 Section "General Commissioning Requirements" for general commissioning process requirements.

1.2 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
 - 5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 6. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 7. Test and inspection reports and certificates.
 - 8. Corrective action documents.
 - 9. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 Testing AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least **10** days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing **Contractor** **10** days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing **Contractor** shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R **Contractor**, testing and balancing **Contractor**, and HVAC&R Instrumentation and Control **Contractor** shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.

- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R **Contractor** shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

END OF SECTION 230800

SECTION 230923 – BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 GENERAL:

- A. The building Automation System (BAS) contractor shall provide a fully integrated direct digital control (DDC) system with software based on existing server/client architecture designed around the open standards of web technology.
- B. Approved Manufacturers: Siemens Building Automation.

1.2 COORDINATION OF TRADES:

- A. Mechanical Division installs all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer.
- B. Electrical Division provides:
 - 1. 120V power to all BAS and/or Temperature control panels
 - 2. Wiring of all power feeds through all disconnect starters to electrical motors
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer

1.3 QUALITY ASSURANCE:

- A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer factory trained personnel.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.4 SUBMITTALS:

- A. Valve and damper schedules
- B. Equipment data cut sheets
- C. System schematics, including:
 - 1. Sequence of operations
 - 2. Point names

3. Point addresses
 4. Interface wiring diagrams
 5. Panel layouts.
 6. System riser diagrams
 - D. Auto-CAD compatible as-built drawings
 - E. PDF of actual Graphics
 - F. Submittal for Cx Review: Controls programming or block logic shall be submitted for review to verify that the programming conforms to the design intent by the Cx Agent. Submit for Cx Agent review once before implementation, once as a virtual simulation, and once again after implementation to verify proper performance. With each submittal include actual graphic. Sample, template or example graphics are not acceptable.
 - G. Upon project completion, submit operation and maintenance manuals, consisting of the following:
 1. Index sheet, listing contents in alphabetical order
 2. Manufacturer's equipment parts list of all functional components of the system, Auto-CAD disk of system schematics, including wiring diagrams
 3. Description of sequence of operations
 4. As-Built interconnection wiring diagrams
 5. Operator's Manual
 6. Trunk cable schematic showing remote electronic panel locations, and all trunk data
 7. List of connected data points, including panels to which they are connected and input device (ionization detector, thermostat, etc.)
 8. Conduit routing diagrams
- 1.5 WARRANTY:
- A. BAS Section shall provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of one year after final completion.
 - B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission, equipment and all sensors and control devices.
 - C. The on-line support services shall allow the local BAS subcontractor temporary use of campus network access using VPN remote access to monitor and control the facility's building automation system. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.
 - D. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the

facility. If the problem cannot be resolved with on-line support services, the BAS subcontractor shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

1.6 OCCUPANCY

- A. The mechanical system serving the branch bank on lobby level and a small area on the Safe Box /SB level will remain occupied. These areas must remain in operation between the hours of 8 a.m. and 5 PM Monday through Friday. No modifications to the system shall cause the mechanical system to be shut down for more than 20 minutes or to fail to maintain space comfort condition during any such period. Perform cutover of controls that cannot meet these conditions outside of above hours.

1.7 TRAINING:

- A. The contractor shall provide factory-trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 am to 3:30 PM weekdays.
- B. Provide training for Owner's designated operating personnel. Training shall include:
 - 1. Explanation of drawings, operations and maintenance manuals
 - 2. Walk-through of the job to locate control components
 - 3. Operator workstation and peripherals
 - 4. DDC controller and ASC operation/function
 - 5. Operator control functions including graphic generation and field panel programming
 - 6. Operation of portable operator's terminal
 - 7. Explanation of adjustment, calibration and replacement procedures
 - 8. Student binder with training modules
- C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If such training is required by the Owner, it will be contracted at a later date.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Performance Standards. The system shall conform to the following:
 - 1. Graphic Display. The system shall display a graphic with 20 dynamic points with all current data within 10 seconds.
 - 2. Graphic Refresh. The system shall update a graphic with 20 dynamic points with all current data within 8 seconds.

3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.
4. Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 60 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 60 seconds. When the alarm is dialed out by modem, this value shall not exceed 2 minutes.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.
9. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.
10. Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2

11. Table 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±0.5°C [±1°F]
Outside Air	±1.0°C [±2°F]
Dew Point	±1.5°C [±3°F]
Water Temperature	±0.5°C [±1°F]
Delta-T	±0.15°C [±0.25°F]
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power factor)	1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10%-100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

12. Table 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa [±0.2" w.g.]	0-1.5 kPa [0-6" w.g.]
	±3 Pa [±0.01" w.g.]	-25 to 25 Pa [-0.1 to 0.1" w.g.]

Airflow	±10% of full scale	
Space Temperature	±1.0°C [±2.0°F]	
Duct Temperature	±1.5.0°C [±3.0°F]	
Humidity	±5% RH	
Fluid Pressure	±10 kPa [±1.5 psi] ±250 Pa [±1.0" w.g.]	0-1 MPa [1-150 psi] 0-12.5 kPa [0-50"w.g.] differential

2.2 GENERAL REQUIREMENTS

A. Sensors

1. All room sensors shall have LCD display for temperature and local set point adjustment knob. The local adjustment capability shall be locked by system software minimum 68°F to maximum 74°F otherwise specified for special range.
2. All immersion pipe sensors and duct sensors shall be RTD, PT100 or PT1000 type. No thermister type sensor allowed for fluid temperature measurement or duct temperature measurement. Outside air and AHU return air relative humidity measurement sensors shall be VAISALA HUMICAP model.
3. All static pressure sensor and relative humidity sensors shall be analytical grade solid state with an accuracy of +/- 1.0%. All outside air and duct mounted relative humidity sensors shall be VAISALA only.

B. All new damper actuator and valve actuators shall be nonstall electronic types.

C. Every AHU coil shall have a discharge air temperature sensor including new terminal boxes and heat pumps.

D. All status for current drawing equipment shall use current transformer type sensor. No dry contact from starter allowed for proof.

2.3 GRAPHIC STANDARDS

A. The control vendor shall modify existing building graphics as now used. It is required that control vendor review the existing graphics prior to developing new graphics for any new projects.

B. Each floor shall have its own floor graphics converted from existing building Auto CAD file. Design Auto CAD files will be provided to the control vendor.

C. All zones shall be colored differently to identify the zone boundary limits. Use construction drawing to identify zones. Show terminal box locations and sensor locations for each zone.

D. All HVAC equipment graphics shall be developed using clip art provided by software manufacturer. Do not use Auto CAD drawing to draw equipment graphics. The control vendor encouraged to copy similar existing equipment graphics from other GSU projects if applicable.

E. Provide all links for related graphics. Floor graphics shall link to related AHU graphics. Room temperature shall link with associated terminal box or AHU. All floor and equipment shall link with the parent building profile link. The building profile graphics shall be developed using building digital photograph. All links shall follow its source For example, floor zone links to

terminal unit of zone damper, terminal unit links to corresponding AHU, AHU links to secondary chilled water pumps, boiler plant and chilled water plant.

- F. All control logic shall request same as graphic links, like zone temperature sensor shall request heat or cooling from corresponding terminal unit, terminal unit shall request its source AHU, AHU shall request its source chilled water pump. Building load in Tons shall request chiller plant to produce chilled water. Same as building load and outside condition shall request for boiler plant for heat.

2.4 CONTROLLERS

- A. Floors shall be controlled by DDC controllers which shall be stand alone, multitasking, multi-user, real-time digital control processors modular type. DDC controllers shall communicate peer-to-peer within network level.
- B. In the event of the loss of normal power, there shall be orderly shutdown of DDC controller to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum 48 hours. Upon restoration of normal power, the DDC controller shall automatically resume full operation without manual intervention.
- C. If any reason DDC controller loose memory the system shall automatically reload the DDC controller from database server via network. The DDC controller shall have an additional RS-232C port to communicate via telephone line.
- D. VAV, WSHP, or Induction Units (IUs) may use canned programmed controllers.
- E. Application specific controllers (ASC) may be used to provide operating equipment information over RS-485 serial communication for VFD's retrofitted to existing pumps and fans. Physical output and input from primary DDC controllers indicated in sec.6.0 (a) shall be used to control all HVAC equipment.

2.5 DDC CONTROLLER:

- A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- B. Each DDC Controller shall have sufficient memory to support its own operating system and databases, including:
 - 1. Control processes
 - 2. Energy management applications
 - 3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - 4. Historical/trend data for points specified
 - 5. Maintenance support applications

6. Custom processes
 7. Operator I/O
 8. Dial-up communications
 9. Manual override monitoring
- C. Each DDC Controller shall support any combination of industry standard inputs and outputs.
- D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
- E. Operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
- F. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
- G. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.
- H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
- J. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 48 hours.
- K. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
- L. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via campus Ethernet from a network workstation PC.
- M. Provide a separate DDC Controller for each AHU or other HVAC system. It is intended that each unique system be provided with its own point resident DDC Controller.
- N. DDC Controller Resident Software Features:
1. General:
 - a. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer for execution.
 2. Control Software Description:

- a. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
 - b. Two-position control
 - c. Proportional control
 - d. Proportional plus integral control
 - e. Proportional, integral, plus derivative control
 - f. Automatic tuning of control loops
3. DDC Controllers shall have the ability to perform any or all the following energy management routines:
 - a. Time-of-day scheduling
 - b. Calendar-based scheduling
 - c. Holiday scheduling
 - d. Temporary schedule overrides
 - e. Start-Stop Time Optimization
 - f. Automatic Daylight Savings Time Switchover
 - g. Night setback control
 - h. Enthalpy switchover (economizer)
 - i. Peak demand limiting
 - j. Temperature-compensated duty cycling
4. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 - a. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network.
 - b. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a remote device such as a printer or text message to cell phone and radio.
5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at the PC workstation, local I/O device or communications with other panels on the network.
 - a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 - b. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 - c. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.
 - d. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character or more alarm message to more fully describe the alarm condition or direct operator response.

6. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
 - a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing Data samples. All trend data shall be available for use in 3rd party personal computer applications.
 - b. DDC Controllers shall also provide high-resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
7. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access shall be limited to authorized personnel through password protection.
8. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O summary.

O. Application Specific Controllers (ASC)

1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs) through LAN Device Networks.
2. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, and real-time digital control processor. Provide the following types of ASCs as a minimum:
 - a. Terminal Equipment Controllers
 - b. Provide for control of each piece of equipment, including, but not limited to, the following: Variable Air Volume (VAV) boxes, WSHP, IU (Induction Units)
 - c. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 PSI pneumatic, allowing for interface to a variety of modulating actuators. Terminal controllers utilizing proprietary control signals and actuators shall not be acceptable. As an alternative, provide DDC Controllers or other ASCs with industry standard outputs for control of all terminal equipment including pneumatic actuation.
3. Connection of a POT to a DDC or ASC Controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally initiated commands and system modification.
4. Portable operator terminal access to controller shall be password-controlled.

2.6 WORKSTATION OPERATOR INTERFACE SOFTWARE:

A. Basic Interface Description

1. Operator workstation interface software shall be an extension of the existing operator interface software.

- B. Provide a graphical user interface, which shall minimize the use of keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.
- C. The software shall provide a multi-tasking type environment that shall allow the user to run several applications simultaneously. These Windows applications shall run simultaneously with the BAS software.
 - 1. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via user-sized windows:
 - a. Dynamic color graphics and graphic control
 - b. Alarm management, routing to designated locations, and customized messages
 - c. Week at a Glance Time-of-day scheduling
 - d. Trend data definition and presentation
 - e. Graphic definition and construction
 - f. Program and point database editing on-line.
 - 2. If the software is unable to display several different types of displays at the same time.
 - 3. Report and alarm printing shall be accomplished via Windows program manager, allowing use of network printers.
 - 4. Reports shall be generated on demand or via pre-defined schedule and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - a. A general listing of all or selected points in the network
 - b. List of all points currently in alarm
 - c. List of all points currently in override status
 - d. List of all disabled points
 - e. List of all points currently locked out
 - f. List of user accounts and access levels
 - g. List all weekly schedules
 - h. List of holiday programming
 - i. List of limits and deadbands
 - j. Excel reports
 - k. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
 - l. List of programs
 - 5. Scheduling and override: Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Schedules reside in both the PC workstation and DDC Controller to ensure time equipment scheduling when PC is off-line; PC is not required to execute time scheduling. Provide override access through menu selection or function key. Provide the following spreadsheet graphic types as a minimum:
 - a. Weekly schedules
 - b. Zone schedules, minimum of 200 unique zones
 - c. Monthly calendars
 - 6. Collection and Analysis of Historical Data
 - a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.

- b. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.
- c. Provide additional functionality that allows the user to view real-time trend data on trend graph displays. A minimum of six points may be graphed, regardless of whether they have been predefined for trending. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed.

D. Dynamic Color Graphic Displays

- 1. Create Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, shall be provided by the BAS contractor as indicated in the point I/O summary of this specification to optimize system performance analysis and speed alarm recognition.
- 2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands. Graphics software shall permit the importing of AutoCAD or Bitmap drawings for use in the system.
- 3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
 - a. Analog bars in 3 sizes shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.
 - b. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
 - c. Equipment state may be changed by clicking on the point block or graphic symbol and selecting the new state (on/off) or setpoint.
- 4. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
- 5. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
- 6. Off the shelf graphic software shall be provided to allow the user to add, modify or delete system graphic displays.
- 7. A clipart library of HVAC and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, and standard ductwork diagrams . The user shall have the ability to add custom symbols to the clipart library.

E. System Configuration & Definition

1. Network wide control strategies shall not be restricted to a single DDC Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
2. Provide automatic backup and restore of all DDC controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
3. System configuration, programming, editing, graphics generation shall be performed on-line.

F. Alarm Management

1. Alarm Routing shall allow the user to send alarm notification to selected printers or PC location based on time of day, alarm severity, or point type.
2. Alarm Notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. These alarm icons shall be displayed when user is working in other Windows programs. The BAS alarm display screen shall be displayed when the user clicks on the alarm icon.
3. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message.
4. Alarm messages shall be customizable for each point to display detailed instructions to the user regarding actions to take in the event of an alarm.

2.7 CONTROL VALVES

- A. Pneumatic valves on the affected floors shall be replaced with electric actuated valves.
- B. This section shall be responsible for selection of proper control valves for the project including line size, pressure rating, temperature rating, flow coefficient, shutoff rating and allowable leakage factor.
- C. All valves installed for two-position operation shall be line size.
- D. Modulating single-seated two-way (straight-thru) valves for chilled water, heating hot water or cooling water service shall be provided with equal percentage contoured throttling plugs.
- E. Valves 2" and smaller shall have ANSI Class 250 rating brass body with screwed connections; larger valves shall have ANSI Class 125 rating, cast-iron body with flange connections. Stems shall be stainless steel.
- F. Modulating straight-thru valves for induction unit service shall have 250 psig brass body, brass plug, brass or stainless steel stem, electric actuators, equal-percentage flow characteristic and back-seating feature.
- G. Modulating water valves shall be sized for 3.0 psi maximum pressure drop.

2.8 DAMPER ACTUATORS

- A. All air handling unit and heating/cooling plant automatically controlled devices, unless specified otherwise elsewhere (see valves for FCU's, TU's and fin tube), shall be provided with electric actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight closeoff.
- B. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital logic with separate analog outputs.

2.9 FIELD DEVICES:

- A. Temperature Sensors - with accuracy of + 0.5 deg F @ 77 deg F)
 - 1. Digital room sensors shall have day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment may be software limited by the automation system to limit the amount of room adjustment.
 - 2. Built-in port allows connection of Portable operator terminal to query and modify operating parameters on room level sensor.
 - 3. Room sensors shall have sensing accuracy of + 0.5 deg F, display accuracy and resolution shall be a minimum of + 1 deg F.
 - 4. Humidity Sensors - with accuracy of + 2% RH @ 77 deg F, range of 20% to 95% RH, including hysteresis, linearity, and repeatability
 - 5. Pressure Sensors – Setra
 - 6. Dampers, sized for specific application
 - 7. Damper Operators, sized for specific application
 - 8. Automatic Control Valves, sized for specific application
 - 9. Air Volume Measurement
 - 10. Smoke Detectors - BRK 120V ionization duct type
 - 11. Low Temperature Detection Stat -
 - 12. Electric Thermostats
 - 13. Differential Pressure Switch

2.10 PROJECT MANAGEMENT:

- A. Provide a designated project manager who will be responsible for the following:
 - 1. Construct and maintain project schedule
 - 2. On-site coordination with all applicable trades and subcontractors
 - 3. Authorized to accept and execute orders or instructions from owner/architect

4. Attend project meetings as necessary to avoid conflicts and delays
5. Make necessary field decisions relating to this scope of work
6. Coordination/Single point of contact

2.11 NAMING CONVENTIONS

- A. The contractor shall collaborate with the owner directly to determine the owner's preference for naming conventions, etc. before entering the data in to the system.
- B. Mechanical equipment naming format: XXX- XXXXX-XXX-XXXXX Building Initial as per university building code – Floor Number – Room Number – Equipment ID from drawing. Example: of the point name for the AHU 1 Supply Air Temperature will be 25PP.MECH.RM.560.AHU1.SAT

2.12 EXISTING CONTROL DEVICES:

- A. The bid for the control work shall be based on the premise that existing control devices are operational and are not in need of repair or replacement, unless otherwise noted.
- B. This subcontractor shall notify the owner's representative of existing control devices that need to be replaced or repaired that may be noted in the process of installation of the new work.
- C. All control system components shown or specified as existing-to-remain shall be tested and verified as fully functional. Notify owner's representative if any existing valves, dampers, or actuators require maintenance.

2.13 NEW AND REUSED EQUIPMENT

- A. The following defines the allowable re-use of existing systems, equipment, components and materials.
 1. Outdoor air dampers on units AC-1 and AC-2 are new. All damper actuators exist and will be reworked to operate the new dampers.
 2. Smoke dampers and smoke detectors in medium pressure supply ducts on 7 and 24 are new. Smoke dampers on floors 22 and 23 are already installed under a previous contract.
 3. All sensors, controllers, control components, transformers, transducers, relays, differential pressure switches, EP devices/switches and PE devices are new.
 4. Piping pressure differential sensors and controllers for pumps P-6, P-7, P-9 and P-10 speed control shall be new unless noted otherwise.
 5. Smoke detectors in AC-5 and AC-6 are new.
 6. VFD's for pumps P-6, P-7, P-9, and P-10 are new.
 7. VFD's for fans AC-2, AC-4, R-1, R-2 and R-4 are new. Static pressure sensors for fans R-1 and R-2 already exist and shall be used in controlling return air fan speed with new VFD's.

8. Pumps for new side stream air separators are new.

2.14 NORMAL POSITIONS FOR VALVES AND DAMPERS

1. Sequences refer to normal valve and damper positions. Where valves or damper actuator are reused, it is not the intent to modify the valve to achieve the normal position referenced in the sequence. If normal position is not as specified, notify engineer.
2. Where actuators are specified to be replaced, verify existing normal position. Where normal positions differ from specification sequence, notify owner's representative prior to ordering valve.
3. Submittal data shall clearly identify valve and damper normal or failed positions that differ from specifications or existing conditions.

2.15 EXISTING EQUIPMENT

- A. Wiring: Do not reuse any abandoned wires. Abandoned wiring shall be removed and become the property of the Contractor, unless specifically noted or shown to be reused.
- B. Conduit: Existing may be reused unless noted otherwise.
- C. Temperature and Pressure Indicator Gauges: Where existing to remain, check and report accuracy.

PART 3 - EXECUTION

3.1 START-UP AND COMMISSIONING:

- A. See 23 08 00.
- B. Demonstrate that all equipment operates as specified in every mode of operation described in the specifications and on the drawings
- C. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.
- D. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

3.2 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing: This testing shall be completed before the Owner's Representative is notified of the system demonstration.
 1. Calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers' recommendations.
4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct.
6. Check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel.
7. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
8. Alarms and Interlocks:
 - a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.3 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed its own tests.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the "Control System Checkout and Testing" Article in Part 3 of this specification. The CxA will be present to observe and review these tests.
3. Approved checklists and forms shall be completed for all systems as part of the demonstration.
4. Demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with System Performance.
7. Demonstrate compliance with Sequences of Operation through all modes of operation.
8. Demonstrate complete operation of Operator Interface.
9. Additionally, the following items shall be demonstrated:
 - a. DDC Loop Response. The Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.

- b. Interface to the building fire alarm system.
- 10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance:

- 1. All tests described in this specification shall have been performed to the satisfaction of both the Engineer and Owner prior to the acceptance of the control system as meeting the requirements of Completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
- 2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 PATCHING

- A. Where control system equipment is removed, patch holes and finish to match existing. Where space sensors or thermostats are specified to be replaced, install new sensors in the same location as the existing. Coordinate size of replacement devices to minimize the need for wall surface repair, painting or re-finishing.

3.5 COORDINATION OF ELECTRICAL AND FIRE ALARM

- A. Prior to bid, communicate to mechanical bidders all requirements and location of new and replacement wells, valves, taps, dampers, flow stations, that will be furnished by BAS manufacturer.
- B. Electrical Drawings show power to control panels or junction box on typical floors. This Section responsible for transformers, power from control panel or junction box to actuators and other control components not shown on electrical.
- C. Electrical power requirements for controls that are not shown on Electrical drawings or Division 26 specifications are responsibility of BAS sub. Power for controls shall meet Division 26 requirements. Power for controls shall be on separate circuits. Circuits shall not be shared with non-control loads.
- D. Prior to bid, communicate all power requirements to electrical bidders. Communicate load and location of power required for BAS and controls to eliminate any gaps or overlap in scope of work between subs.
- E. Prior to bid, communicate all power requirements to fire alarm system bidders. Prior to bid, coordinate line of demarcation to eliminate any gaps or overlap between fire alarm system bidders and BAS section.

3.6 DEMOLITION AND REMOVAL OF EXISTING CONTROLS

- A. The intent is to remove all existing un-used and inoperative controls. Includes panels, power wiring, low voltage wiring, and pneumatic piping and components.

- B. Un-used and in-operative air compressors, driers and tanks shall be removed. GSU facilities may want to take possession of air compressors and driers. GSU has first right of refusal. Coordinate with GSU.

END OF SECTION 23 09 23

SECTION 230924 - BAS SEQUENCES

PART 1 - GENERAL – not used

PART 2 - PRODUCTS – not used

PART 3 - EXECUTION

3.1 GENERAL SEQUENCE OF OPERATION REQUIREMENTS

- A. Microprocessor based controls: All control functions shall be microprocessor based unless otherwise specified. All start/stop schedules shall be through the BAS. Separate electric, electronic or electromechanical time clocks are not acceptable unless specified otherwise.
- B. Fixed time: Provide individual occupied/unoccupied or start/stop time for all new HVAC equipment and where specified in the Sequence of Operation. Includes each of the following:
 - 1. Water Source Heat Pumps
 - 2. Terminal Units
 - 3. Air and Dirt Separator Pumps
- C. Alarms: All analog inputs shall have high and low alarm points programmed to alarm at BAS. Critical points shall be programmed to print out alarm conditions at any printer assigned by the BAS Operator. Initially program to print out at the BAS Room. If any piece of HVAC equipment is abnormally stopped, it shall be treated as a critical alarm. BAS operator shall have capability to assign alarm classification to any point. A mismatch alarm shall be indicated whenever a mismatch condition exists between any associated BAS command and BAS status points. Mismatch shall be treated as a general alarm.
- D. Historical data: All alarms shall be recorded in Historical Data.
- E. Trend logs: Initially provide trend logs for all binary points (log indicates each change of state, each on or off) and provide trend logs for all analog points. This data will be used for commissioning of the building.
- F. Set points shall be user adjustable from central processing unit in BAS Room, from graphic which displays values and from the local control panel. Reference the Equipment Data Sheets/ Existing Equipment Schedules for setpoints to be used in setting up the BAS system. Confirm final setpoints, especially room or space temperature, leaving air temperatures and humidity, with Owner and CxA. Prior to demolition, confirm existing setpoints with hard copy print-out or downloaded file from the existing DSC's.
- G. Sensors: Restore analog current sensing for pumps and fans: AC-1, AC-2, AC-3, AC-4, AC-5, AC-6, R-1, R-2, R-4, P-6, P-7, P-9, P-10 after replacement of motors and drive hardware.
- H. Dampers: All outdoor and relief air dampers shall be fail safe type that fail closed unless specified otherwise. New smoke dampers will be installed on 7 and 24. Dampers will be fail safe type that fail closed.
- I. Voltage Coordination: Coordinate analog point requirement of 0-10 V dc or 4-20 Ma with equipment.

- J. Coordinate voltage requirements of all control equipment especially those furnished with equipment or by other sections such as variable speed motor controller,
- K. Start/stop schedules: Confirm all start/stop schedules with Owner and CxA before final software set-up.
- L. Control action: All modulating control action shall be proportional + integral + derivative unless specified otherwise.
- M. Equipment, valve and sensor identification: Develop a system of names or acronyms for use in identifying equipment, valves, sensors, etc. that will allow easy BAS reference. Identification used in this specification shall be used as a guide.
- N. Time delays: With all control functions, provide the necessary time delays in software to allow equipment, equipment controls or systems to respond to BAS commands. Provide the necessary delays to allow dampers and valves to open prior to starting associated equipment. Delay pump starting until associated valves have opened. Delay fan starting until associated dampers have opened.
- O. Multi-stage Equipment: For all multistage equipment, especially electric heaters, boilers and chillers, provide analog or binary output for each stage or provide an analog output signal to allow each stage to be energized separately. It is not acceptable to combine or group stages.
- P. Motors with HOA:
 - 1. With HOA switch located on the motor starter in "hand" or "on" position, motor shall operate subject to safeties in associated systems and shall not override safeties intended to protect the associated system or system components.
 - 2. In "off" position, motor shall stop.
 - 3. In "auto" position, motor operation shall be controlled through the BAS.
- Q. Programming: Phased occupancy will require program changes during the first year of occupancy. Include time to make program changes at 3, 6, and 9 months after Material Completion for no additional cost unless change requires additional points or materials.

3.2 SECONDARY (INDUCTION) LOOP PUMPS

- A. Variable Speed Chilled Water Pumps P-6 and P-7:
 - 1. Existing constant speed CHW pumps P-6 and P-7 will be converted to variable speed.
 - 2. Provide sensors and points to operate variable speed pumps.
 - 3. Sequence
 - a. Modulate speed to maintain pressure differential setpoint on the 14th floor.
- B. Variable Speed Chilled Water Pumps P-9 and P-10:
 - 1. Existing constant speed CHW pumps P-6 and P-7 will be converted to variable speed.
 - 2. Provide sensors and points to operate variable speed pumps.
 - 3. Sequence
 - a. Modulate speed to maintain pressure differential setpoint on the 13th floor.

3.3 AIR HANDLING UNITS AC-1 and AC-2 – NEW OA DAMPER SECTIONS

A. Airside Economizer:

1. With outside air enthalpy below 23 btuh/lb (55 DB/55 WB), system shall operate in the economizer mode. Outside air enthalpy shall be continuously monitored and compared to return air enthalpy. When the outside air enthalpy is 5 btuh/lb less than return air enthalpy and the space requires cooling, the system will operate in Airside Economizer Mode.
2. With economizer mode enabled, modulate the maximum outside air dampers in sequence and return damper to maintain the mixed air temperature setpoint.
3. Provide separate analog outputs for each maximum outside air dampers, each minimum outside air dampers, relief air dampers and return air dampers.
4. Setpoints for economizer systems: Initially set Economizer Setpoint to 23 btuh/lb 55 DB/55 WB.
5. To allow BAS Operator to monitor economizer operation, provide a separate graphic listing return air temperature, RH and calculated enthalpy for all air handling units, along with outside air temperature, RH and calculated enthalpy and economizer setpoint.

B. Airflow Measurement

1. Measure outdoor airflow utilizing existing flow stations for outside air.

C. Outside Airflow Control:

1. Using Air Flow Measuring: utilize existing outside airflow measuring station (AFMS) in the outside air ducts:
 - a. With AHU or Air System in the Occupied mode, open the outside air damper and modulate the return air damper to maintain the outside airflow rate as measured by the AFMS.
 - b. With AHU or Air System in the Occupied mode, open the outside air damper to the normal or low occupancy position.
2. Variable Outside Airflow Rates:
 - a. Provide user adjustable outside airflow rates.
 - b. Flow rates will vary depending on number of floors occupied. Low flow rate shall be used when exhaust fans are on low speed or when exhaust fans are Off (such as nights and weekends) but building supply must operate to maintain building pressure and space high or low limit temperature setpoints.
 - c. Occupancy status shall be as scheduled by BAS operator. During low occupancy periods, outside air shall be controlled to low occupancy operator adjustable flow rate. During normal occupancy periods, outside air shall be controlled to normal occupancy operator adjustable flow rate.
 - d. Adjust AFMS setpoint or mixing box static pressure setpoint to change from normal to low rates.
 - e. Using measurements by the Test and Balance Contractor, establish the static pressure differential and damper position that corresponds to the normal and low airflow.
 - f. Setpoints for Outside Airflow Rates: The setpoints for the outside airflow rates will be provided at a later date and shall be easily adjustable by BAS operator from graphic.

D. Fan Speed Control, Duct Static and Building Static

1. Modulate variable speed drive to maintain the duct static pressure setpoint.
 - a. For AC-2, duct static pressure will be sensed on each floor and fan discharge
 - a) For floors with Terminal Units installed (22-24) modulate smoke damper on each floor to maintain duct static pressure of 0.5 inches. Provide auto setpoint adjustment based on dampers position.
 - b) Locate duct static as shown on drawings or if not shown, locate 2/3 distance.
 - c) Modulate fan speed to maintain duct static pressure in fan discharge.
 - d) Provide cascading control logic to reset fan discharge setpoint based on floor level duct static pressure.
 - e) Monitor operation during warranty period and adjust logic to minimize fan energy.
 - b. For AC-4, duct static pressure will be sensed on each floor and at fan discharge.
 - a) For floors with Terminal Units installed (Initially 6 thru 11) modulate smoke damper or combination fire/smoke damper on each floor to maintain duct static pressure of 0.5 inches. (with auto setpoint adjustment based on dampers position),.
 - b) Locate duct static as shown on drawings or if not shown, locate 2/3 distance.
 - c) Modulate fan speed to maintain duct static pressure in fan discharge.
 - d) Provide cascading control logic to reset fan discharge setpoint based on floor level duct static pressure.
 - e) Monitor operation during warranty period and adjust logic to minimize fan energy.
 - c. For R-1, duct static pressure will be sensed at inlet to fan on 27th floor, discharge of fan, and on each floor.
 - a) Modulate smoke damper or combination fire/smoke damper on each floor to maintain return plenum static pressure of 0.03 inches,
 - b) Locate duct static as shown on drawings or if not shown, locate in plenum near core at location approved by engineer.
 - c) Modulate fan speed to maintain duct static pressure in fan discharge.
 - d) Provide cascading control logic to reset fan discharge setpoint based on return plenum static pressure.
 - e) Monitor operation during warranty period and adjust logic to minimize fan energy.
 - d. For R-2, duct static pressure will be sensed at inlet to fan on CR level, discharge of fan on CR level, and on each floor.
 - a) Modulate smoke damper or combination fire/smoke damper on each floor to maintain return plenum static pressure of 0.03 inches,
 - b) Locate duct static as shown on drawings or if not shown, locate in plenum near core at location approved by engineer.
 - c) Modulate fan speed to maintain duct static pressure in fan discharge.
 - d) Provide cascading control logic to reset fan discharge setpoint based on return plenum static pressure.
 - e) Monitor operation during warranty period and adjust logic to minimize fan energy.
2. For this Phase, variable speed fans installed and static pressure controls enabled for AC-2, AC-4, R-1, R-2. Controls for other systems will be disabled until variable speed drives are installed.
3. Where duct static sensors are in shafts, provide fire rated panel in shaft wall for access to sensor.

4. Duct Static Pressure Setpoint Adjust:
 - a. For AC-2 and AC-4: Fan energy shall be minimized through duct static pressure setpoint adjustment. If supply air temperature has reached the maximum setting and all boxes are less than design airflow, reset duct static pressure down in increments of 0.05" W.C. every ten minutes until any terminal unit damper is in the design airflow - full open position. Reverse sequence when any terminal unit airflow less than design with damper full open.

3.4 FIRE COMMAND CENTER and FLOOR DAMPER CONTROL

- A. Provide control of new smoke dampers on floors 7 and 24 from the Fire Command Center (FCC) as part of the Fire Alarm System (FAS)
- B. FCC is located in Lobby for fire fighter manual override of fan shutdown. The FCC will enable the fire fighter to override the normal shutdown of the AHU systems to manually purge or pressurize floors.
- C. Provide one static pressure sensor on each of floors 7 and 24 to monitor floor static pressure. Measure floor static pressure relative to outside air.
- D. The FCC is not intended to be an approved smoke control system as defined by International Code or NFPA. Components and control devices used in the system shall have UUKL listing. Wiring shall meet requirements for an approved smoke control system.
- E. Control of fans, AHUs and Dampers is through the BAS. FCC receives input and sends signal to the BAS. The FCC indicates system and equipment status. Selector switch signals the BAS.
- F. FCC shall include:
 1. Positive, Negative, Auto manual selector switch for each floor and
 2. Lights showing status of AHUs, fans,
 3. Outside air damper position, relief air damper position and return air damper position.
- G. Floor Damper Operation from FCC:
 1. With switch in Negative (Hand) position, supply dampers close, and return and exhaust dampers open.
 2. With switch in Positive (Hand) position, supply dampers open and return and exhaust dampers close.
 3. With switch in Auto Position, all dampers close on signal from the fire alarm system as described with AHUs. Activation of duct smoke detector shall signal fire alarm system and shut down Air Handling Systems. Signal from fire alarm system including any space smoke detector, pull station, or sprinkler flow switch, air systems shall stop and dampers close.
- H. Central AHUs and EF Operation from the FCC
 1. With any selector switch on floor 2- 13 in either Positive or Negative (Hand) position, AC-3, AC-4, R-2, E-10, E-11, and all associated controls, operate.

2. With any selector switch on floor 14 - 26 in either Positive or Negative (Hand) position, AC-1, AC-2, R-1, E-10 and E-11, and all associated controls, operate.
3. In smoke purge mode,
 - a. Outside air dampers shall open
 - b. Return air damper shall close.
 - c. Relief/spill air damper shall open.
 - d. Supply, return and exhaust fan shall operate to maintain purge duct static pressure setpoint.
4. For this Phase, fans for upper floors system will be disabled until variable speed drives are installed on AC-1, AC-2, and R-1.

I. Unoccupied Floor Damper Operation:

1. In addition to control from FCC, provide BAS operator control of smoke dampers on each floor to isolate unoccupied floors for operating efficiency.
2. BAS operator shall have the ability to individually close the smoke dampers in the
 - a. supply to Induction Units (AC-1 and AC-2, perimeter/exterior),
 - b. supply to Interior (AC-2 and AC-4), modulating control,
 - c. return (R-1 and R-2), Modulating control and
 - d. exhaust (E-10 and E-11)
 - e. on each of floors 2-26.
 - f. Requires four separate output signals for each floor.
3. Unoccupied floor damper control shall not override the fire alarm controls.
4. AHU speed, valve and central damper positions remain normal.
5. For this Phase, Unoccupied Floor Damper Controls for upper floors will be disabled until variable speed drives are installed on AC-2 and R-1.

3.5 TERMINAL UNITS – VARIABLE AIR VOLUME (VAV)

- A. Variable Air Volume (VAV): Primary air damper shall modulate to maintain space temperature setpoint. Primary air damper shall modulate between min and max to maintain cooling temperature setpoint.
- B. In unoccupied mode, operate to maintain night setback and set-up temperature.
- C. Damper Override: Minimum velocity or airflow (cfm) setpoint shall be reset to allow maximum design airflow rate through Terminal Unit when floor commanded to positive pressure mode.
- D. Adjustable thru BAS: Space Cooling/Heating setpoints, Primary Airflow Min/Max setpoints, Unoccupied (Night) setback/set-up temperature setpoints, Fan Speed Min/Max Airflow, Primary Airflow setpoint for pressurization mode.
- E. Provide read and reset of controller via either connection at the space sensor or unit controller.
- F. Provide graphic showing all monitored and controlled points. Provide table showing all units on each floor.

3.6 INDUCTION UNITS

- A. Modulate new control valve to maintain space temperature. Monitor leaving air temperature.
- B. With secondary system in heating mode, valve modulates open to maintain heating setpoint.
- C. With secondary system in cooling mode, valve modulates open to maintain cooling setpoint.
- D. In unoccupied mode, operate to maintain night setback and set-up temperature.
- E. Adjustable thru BAS: Space Cooling/Heating setpoints.
- F. Unit controller access via connection at either the space temperature sensor or unit controller.
- G. Provide graphic showing all monitored and controlled points. Provide table showing all units on each floor. Provide table with all units grouped vertically by orientation South, West, North, NE and SE with AC-1 and AC-3 zone supply air temperature.

3.7 RELATIVE HUMIDITY SENSING AT INDUCTION UNITS

- A. Provide combination Temperature and RH sensors at five (5) locations on each floor with new induction unit valves installed.
- B. See Secondary Water Systems SOO. Calculated average dewpoint temperature is referenced to limit secondary chilled water temperature. Operation of secondary water temperature below space dewpoint may result in condensation at induction units and water on floor.
- C. Calculate floor average and compare to each sensor on floor. Compare calculated dewpoint for each floor and alarm if any combination sensor exceeds floor average by two (2) degrees F.
- D. Calculate building average and compare to each floor average. Compare the average calculated dewpoint for all floors and alarm if any floor average exceeds building average of by two (2) degrees F.
- E. Provide graphic showing all monitored and calculated values. Provide table showing all on each floor. Provide table with all units grouped vertically by orientation South, West, North, NE and SE with AC-1 and AC-3 zone supply air temperature

3.8 ROOM TYPE TEMPERATURE SENSORS LOCATIONS

- A. Unless noted otherwise, locate new sensors for handicapped accessibility in accordance with ADA requirements. If near light switch, position sensor six inches next to light switches and align centerline of sensor with centerline of light switch. Where handicapped access is required, locate 48 inches above floor.
- B. Do not locate sensor over heat generating controls such audio, video or lighting dimmers. For these locations, locate sensor six to eight inches to left or right of dimmer.
- C. Do not locate sensor over induction units, fin tube radiation, convectors or other similar heating or cooling units.
- D. Where sensors are shown on columns, coordinate location with partition layout.
- E. Locate all sensors out of direct sunlight.

- F. Where sensors are shown on exterior walls, insulate base and seal to eliminate effects from conduction and infiltration.

3.9 WATER SOURCE HEAT PUMP (WSHP) – EACH

A. New:

1. Fan Operation:
 - a. Provide controls to allow user selection of fan operating mode as on/off with load or constant.
 - b. Initially set fan to cycle to maintain room temperature with a minimum 30 minute on and 15 minute off anti-recycle setpoints.
2. Valve Operation: Open WSHP water valve on call for cooling to maintain room setpoint.

3.10 AIR AND DIRT SEPARATOR PUMPS

A. New:

1. Pumps shall operate continuously in occupied mode.
2. In unoccupied mode, operate whenever induction system operates to maintain night setback and set-up temperature.

3.11 LIGHTING CONTROL

A. Existing:

1. Each floor has two contactors that each control approximately eight to ten lighting circuits. As-built drawings are not available.
2. Each of two contactors is manually controlled by a key switch. Circuits are generally grouped into North and South areas of each floor.

B. New:

1. Lighting electrical has not been re-circuited except in the renovated areas. Re-circuiting is not required by this specification except as shown on the electrical drawings.
2. For floors 7 and 22 thru 24, provide occupant override control in same location as existing key switch.
3. Each override switch shall be a separately recognized binary input to the controller. The controller shall be fully programmable to allow any override switch to be associated with any output zone or multiple zones.
4. Initially set-up override to turn-on lights for 30 minutes if pushed one time and 60 minutes if pushed two or more times.
5. Provide 365 day/24 hour programmable sweep-off function to shut-off the lighting outputs. Each output shall have individual schedule. A time delay shall be provided between each Off command.

6. Provide Flash-Before-Off feature to flash or blink light on/off for an adjustable amount of time before the unoccupied period begins and flash before the end of an override period. Initially set flash for two minutes before Off.
7. Provide remote after-hours lighting requests for separate approved account/users via web browser. System shall log all after hours requests, allow unique accounts and passwords for each user and provide for an afterhours request totalizer and billing/report package. Provide supervisory control to track and limit account user override capability.
8. Provide normal-hours use and an after-hours use reporting that tracks daily, monthly and annual use for each relay for energy tracking.

END OF SECTION 23 09 24

[illegible]

INPUT OUTPUT SCHEDULE

DESCRIPTION	Input/Output				NOTES
	BI	AI	BO	AO	
BUILDING: 25 PARK PLACE TOWER					BI= Binary Input; AI= Analog Input; BO=Binary Output; AO= Analog Output.;
SYSTEM: AIR HANDLING UNITS					
RETURN FAN R-2					
S/S Command			X		
Status		X			
Return Duct Static Pressure (Fan discharge)		X			
Return Duct Static Pressure (Fan suction)		X			
Return Duct Static Pressure (End of shaft)		X			Pressure sensor installed previously
Return Fan Speed				X	
VFD				X	
RETURN FAN R-4					
S/S Command			X		
Status		X			
Return Duct Static Pressure (Fan discharge)		X			
Return Duct Static Pressure (Fan suction)		X			
Return Duct Static Pressure (End of shaft)		X			Pressure sensor installed previously
Return Fan Speed				X	
VFD				X	
VAV TERMINAL UNIT (EACH)					See Plans for number and location
Damper				X	
Room Temperature		X			
Duct Velocity		X			
Supply Air Temperature		X			Required - even though no heating coil.
RELATIVE HUMIDITY (RH) (EACH)					Five for each of floors 7, 22 thru 24
Room RH level		X			
WSHP (EACH)					See Plans for number and location
Start/Stop			X		
Room Temperature		X			
Control Valve			X		
Alarm/Water detected			X		One common for general and water
Status			X		Various point thru BACnet. See spec section
SMOKE DAMPERS (Each - floors 7 and 24)					
Supply Damper (2)				X	Two AO for two Interior supply duct dampers
Differential Static Pressure - Relative to Outside		X			Each Floor with New Smoke Dampers
AIR & DIRT FILTER PUMPS PCR-1 AND PPH-1					
S/S Command			X		
Status		X			

End of Section 23 09 25.

SECTION 232113 - HVAC PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Section Includes Pipe and Pipe Fittings for:
 - 1. Auxiliary cooling (condenser) water;
 - 2. Drain pipe for AC unit condensate (water source heat pumps);
- B. Related Sections:
 - 1. Mechanical General Provisions: Section 23 05 00.
 - 2. Basic Mechanical Materials and Methods: Section 23 05 00.

1.2 SUBMITTALS

- A. Submit product data, for each product specified in this section.
- B. See 23 05 00 for additional general requirements.
- C. Prepare shop drawings, not smaller than 1/4" =1'0" scale, showing the piping and equipment in mechanical rooms including air handling equipment rooms; include floor plans and sections or isometric views.
- D. These drawings may be either separate from or combined with the coordinated layouts of air handling equipment and ducts in mechanical equipment rooms specified under shop drawings in the Air Distribution Section, but in either case, the piping shall be laid out to avoid interference with other work, permit access for maintenance, and make proper connections to the equipment that is to be installed.
- E. Comply with the requirements for checking and coordination of Shop Drawings specified in the Mechanical General Provisions Section 23 05 00. Promptly upon receipt of a copy of the Air Distribution Shop Drawing for any floor or area, check the proposed routing of the HVAC piping against the work shown on the shop drawings and arrange to coordinate the work to avoid interference.
- F. Submittal shall clearly indicate where products are to be applied. Provide table showing each piping system with pipe size, pipe material and fitting material and piping location.

PART 2 - PRODUCTS

2.1 PIPING

- A. Auxiliary cooling (condenser) water:
 - 1. Size: Up to 2 inch.
 - a. Pipe: Copper, Type L Hard Drawn, ASTM B88.

- b. Fitting: Wrought Copper or bronze solder joint pressure fittings, Brazed, ASTM B16.22.

B. Drain Pipe for AC Unit Condensate (Computer Room Units):

- 1. Size: Up to 2 inch.
 - a. Pipe: Copper, Type DWV, ASTM B88.
 - b. Fitting: Wrought Copper, Brazed.

2.2 BRAZING

A. All Water Systems With Copper Piping:

- 1. Sil-fos silver- copper-phosphorus brazing filler metal

B. FITTINGS

- C. General: Pressure ratings of all fittings shall be equal to or greater than the design pressure of the systems in which they are installed. All fittings shall be manufactured from a material that is compatible with the pipe material.
- D. Reducers/Elbows: Factory made fittings, machine-made bends may be used, miters shall not be used.
- E. Tees/Wye Laterals: Factory made fittings, or forged steel Bonny Weldolets or forged steel Watson-Stillman Teelets or Allied Branchlet type 1 or 2 branch fittings may be used on 2" and larger pipe where the branch is smaller than the main. 45-degree branch connections and elbow outlets may be made with Bonny Forge Latrolet and Elbolet forged welding fittings.
- F. Screwed Fittings: ANSI B16.3 150 lb. standard malleable iron or 300 lb. ductile iron threaded fittings.

2.3 UNIONS

- A. Steel Piping: Bolted flange type with gasket; 2" and smaller unions may be ground joint brass seat type; pressure ratings of unions shall equal or exceed that of the pipe fittings; bolted type grooved end joint couplings may be used as unions in piping where specified as an acceptable type of joint.
- B. Copper Piping: Wrought or cast bronze Fed Spec WW-U516C, solder end joints.

2.4 DIELECTRIC UNIONS

- A. Description: Insulated type to prevent corrosion due to galvanic action between dissimilar metals.
- B. Size: 1/2 thru 2-1/2"
- C. Description: Brass O-Ring Type union, Viton 'O' ring, brass nut and tailpiece with threaded, soldered, reduced size or grooved end.
- D. Rating: 400 psig at 275 deg F.

- E. Manufacturers: Flow Design, Inc Model UP, Appolo Model UA or equal.

2.5 DIELECTRIC NIPPLES

- A. Description: Steel MPT x MPT nipple with minimum of 2 inch long thermoplastic liner for dielectric separation.
- B. Rating: 300 psig at 225 deg F.
- C. Manufacturers: Flow Design Inc, Model DN.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream and deburr all pipe and tubing.
- B. Clean all debris from pipe (inside and outside) and fittings (inside and outside) before installation.
- C. Inspect mating flange surfaces. Verify bolt sizes, materials, and lengths. Verify that gaskets are free of defects, properly sized, and composed of the correct material.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. See Section 23 05 00 for additional general requirements.
- C. Install fittings at all branch connections and changes in direction.
- D. Install piping parallel or at right angles to building walls. Diagonal pipe runs are only permitted as indicated on the drawings.
- E. Provide adequate space around piping to allow proper application of insulation. Minimum allowable clearance shall be 1 inch, all around.
- F. Space individual pipes to permit servicing of system components.
- G. Install piping sag-free and bend-free.
- H. Support and anchor piping as specified elsewhere in Division 15.
- I. Exposed piping is indicated on drawings. Conceal all other piping.
- J. Branch connection takeoffs shall be out of the top of the main when feeding up, and the bottom of the main when feeding down.
- K. Drain piping from cooling coils shall be not smaller than the drain pan outlets and shall not contain any 90 deg fittings. For 90 deg changes in direction, use "Y" and 45 deg fittings with cleanout plug.

- L. Provide water seal trap with cleanout in each FCU drain line.
- M. For chilled and auxiliary cooling (glycol) water piping, slope piping at uniform grade of 1 inch upward per 40 feet of run in direction of flow where space permits.
- N. For chilled and auxiliary cooling (glycol) water piping, install eccentric reducers with the flat side on the top of horizontal piping.
- O. For condensate drain piping, install eccentric reducers with the flat side on the bottom of horizontal piping.
- P. Install piping so that it does not leak.

3.3 UNIONS

- A. Install unions on threaded piping at valves and equipment. (Flanged devices do not require unions).
- B. Provide dielectric unions when joining two dissimilar metals.

3.4 PIPING AT WATER COILS

- A. Offset piping to minimize strain due to expansion and contraction. Offset shall include at least two elbows in piping between main and coil.
- B. When coil is inside unit with externally mounted vibration isolation, install piping with swing joints sized to allow for vibration.
- C. Piping shall not block the use of access doors, panels, filter, valves or other equipment.
- D. Install piping clear of electrical equipment including disconnect switches, starters and control panels.
- E. Pipe hangers shall support the piping. Support from the coil is not acceptable.
- F. Where more than one coil is used, the area of the branch piping to the individual coils shall equal or exceed the area of the combined branch piping. Velocity through any branch shall not exceed 6 feet per second.

3.5 JOINTS

- A. Threaded Joints:
 - 1. Form tapered pipe threads in compliance with ANSI/ASME B1.20.1.
 - 2. Use clean sharp dies to cut threads.
 - 3. Ream ends to restore pipe's inside diameter and deburr.
 - 4. Apply joint compound or sealant to male threads at all joints.
 - 5. Use compound or sealant, which is compatible with the intended service.
- B. Flanged Joints:
- C. Weld flanges to pipe ends and equipment in accordance with ANSI/ASME B31.1.

- D. Clean flange faces and install gaskets.
- E. Compress gasket uniformly by tightening bolts in proper sequence.

3.6 COPPER TUBING

- A. Conform to bending procedures and techniques described in the Copper Tube Handbook (CDA 404/0-R).
- B. Brazing: Conform to soldering and brazing procedures and techniques described in the Copper Tube Handbook (CDA 404/0-R).

3.7 INSTALLED IN THIS WORK BUT SPECIFIED ELSEWHERE

- A. Sensing devices, control valves.
- B. Wells for temperature control sensors.

3.8 TESTING

- A. Hydrostatically test each piping system when complete including all valves, fittings, temperature control devices and piping system components.
- B. Minimum Test Pressure: 1-1/2 operating pressure.
- C. Maximum test pressure: lowest test pressure rating of any system components.
- D. Duration: Four hours without any loss of pressure.
- E. Pneumatic testing is not acceptable.

3.9 ADJUSTING

- A. Ready hydronic systems for testing and balancing.
- B. Adjust temperature controls so that all coils receive full flow.
- C. Set equipment operating temperatures to design requirements.

3.10 CLEANING

- A. See Section 15056 for piping cleaning requirements.
- B. Replace any start-up strainers with final strainers after flushing is complete and before balancing.
- C. All piping shall be flushed out or blown out after pressure testing is complete and before being put into use.
- D. After start-up and testing, strainer screens shall again be removed and cleaned.

- E. Contractor to maintain log of flushing and strainer cleaning dates and times. Log shall include comments regarding strainer cleaning.

3.11 COMMISSIONING

- A. Operate system for testing and balancing.

END OF SECTION 15510

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Alignment of separately coupled, horizontally mounted, in-line centrifugal pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pump.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings..

C. Motor: Single speed and rigidly mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Open, dripproof.
 - b. Motor Bearings: permanently lubricated ball bearings.
 - c. Efficiency: Premium efficient.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Equipment Mounting: Install in-line pumps to be supported by adjacent piping.

3.2 ALIGNMENT

- A. Perform alignment service at flexibly-couple base-mounted pumps where the motors are replaced: P-6 and P-7 in the Penthouse; P-9 and P-10 in the Level CR mechanical room.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valves and flow manual balancing valves on discharge side of in-line close-coupled pumps.
- E. Install Y-type strainers and shutoff valves on suction side of in-line close-coupled pumps.

- F. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 232123

SECTION 232500 - WATER TREATMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. Chemical water treatment equipment, service and chemicals.

B. Related Sections:

1. Mechanical General Provisions: Section 23 05 00.

1.2 SUBMITTALS

- A. Product data, for each product specified in this section.
- B. Name and address of Water Treatment Company.
- C. Qualifications, including years in business.
- D. Cleaning certificates.
- E. Cleaning procedures.
- F. Product data for equipment and chemicals.
- G. Certificate of cleaning.
- H. See 23 05 00 for additional requirements.

1.3 QUALITY ASSURANCE

- A. A single water treatment company shall be responsible for all products and services and be a recognized specialist in the field of industrial water treatment for a minimum of 10 years.
- B. The water treatment company shall have access to regional water analysis laboratories, research and development facilities, plus technical service representatives located within the trading area of the job site.
- C. The chemical water treatment shall conform to all applicable Codes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, WATER TREATMENT COMPANIES

- A. Acceptable water treatment companies, chemical and equipment manufacturers are as follows:
 - 1. Betz Laboratories, Inc.
 - 2. Garratt-Callahan
 - 3. A & W Technologies Inc, Atlanta, GA 770-455-9224

2.2 GLYCOL PIPING SYSTEMS

- A. Feeding Equipment: Furnish a shot feeder, minimum 2-1/2 gallon capacity, designed to meet the pressure requirements of each specific system. Feeder shall be rated for 250 psi service and shall be supplied complete with quarter turn cap, 3-1/2" opening, fill valve, inlet valve, air vent cock and outlet valve. A separate feeder shall be supplied for each system. The feeder size shall be as required based on the water content of each system.
- B. Each feeder shall be equipped with a filament polyester filter bag capable of removing solids of 5 microns. Provide six replacement bags.
- C. Water Treatment Chemicals: Furnish an initial supply of the recommended formula for scale and corrosion protection of the new portion of the closed re-circulating condenser water system. Formulation shall not contain any ingredients, which are harmful to system materials of construction. Chemicals shall be in liquid form.
- D. Testing: Furnish basic test kit to test for corrosion inhibitor level in each closed loop system, complete with carrying case and reagents.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's and water treatment company instructions.
- B. See Section 23 05 00 for additional general requirements.
- C. Provide all piping, valves, fittings, equipment, accessories, chemicals and service necessary to provide a complete and operable water treatment system and water treatment program.

3.2 WATER MANAGEMENT PROGRAM AND CHEMICAL SUPPLY

- A. The water treatment company shall provide a water management and service program to include the following: initial water analysis and recommendations, system start-up assistance, training of operating personnel, periodic field service and consultation, any necessary log sheets and record forms, and any required laboratory and technical assistance, all performed by a qualified full-time local representative; customer report charts and log sheets plus laboratory and technical assistance at no additional charge. The initial supply of chemicals, water

management and service shall be for the period from initial system cleanout to date of substantial completion, when the systems are being operated by the Contractor.

- B. A 90-day supply of chemicals, water management and service shall be provided to the Owner for a period of 90 days from the date of substantial completion (beneficial occupancy) at no additional charge.
- C. The water management program after the date of substantial completion shall include one service visit at 30 to 40 days after that date. Microbiological test of cooling water reported by a State approved laboratory shall be made within three weeks of the date of substantial completion.

3.3 SYSTEM CLEANOUT AND PREPARATION

- A. Flush system with water to remove all the loose debris which could later be circulated and deposited in locations at which blockage or corrosion may result. The flushing must be conducted without damaging equipment, such as valves, pumps, sensors, switches, etc., or contaminating equipment that is difficult to clean, such as chillers, fan coil units, etc. To achieve this, the system shall be divided into small circuits with sensitive components removed, isolated or bypassed.
- B. In order to remove the debris, provide supplementary pumps to create velocities in excess of the design velocities. To ensure the removal of the debris, the outlets shall be large enough not to restrict the flow through the pipework.
- C. Provide all valves, fittings and piping necessary for flushing and cleaning.
- D. All HVAC piping systems, boilers, heat exchangers and related equipment shall be thoroughly flushed out with pre-cleaning chemicals designed to remove deposits from construction, such as pipe dope, oils, most loose mill scale, and other extraneous materials. The products shall inhibit corrosion of the various metals in the system and shall be safe to handle and use. Effectiveness of the product shall be such that the water need only be at ambient temperatures. Add recommended dosages of chemicals and circulate for 24 hours. Systems shall then be drained and flushed until the total alkalinity of the rinse water is equal to the make-up water. Refill with clean water and treat to prevent scale and corrosion during operation of the water systems.
- E. The Contractor shall perform the flushing and cleaning.
- F. The chemical water treatment company shall furnish the chemicals, supervise the cleaning and provide a certificate verifying the execution and satisfactory completion of cleaning procedures.

END OF SECTION 23 25 00

SECTION 232913 - ENCLOSED COMBINATION MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed full-voltage combination magnetic controllers, rated 600 V and less.

1.2 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.

1.3 SUBMITTALS

- A. For Approval, submit Product Data for each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 1. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate **Class R** fuses.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - 2. Configuration: nonreversing.
 - 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 24V ac; obtained from integral CPT, with primary and secondary fuses. CPT shall be Class B, and of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 6. Auxiliary Contacts: provide one N.O. contact and one N.C. contact, arranged to activate before switch blades open.
 - 7. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - 8. MCCB Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, Type 1.

2.3 ACCESSORIES

- A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.
- B. Control Relays: Auxiliary and adjustable time-delay relays.
- C. One N.C. and one N.O. auxiliary contact.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Install fuses in each fusible-switch enclosed controller.
- C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. NETA ATS allows three methods to test and inspect bolted electrical connections for high resistance; the infrared (thermographic) method is the most thorough and costly. Retain first subparagraph below if this method is preferred.
 - 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches and overload-relay pickup and trip ranges.
- B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 232913

SECTION 232923 – VARIABLE FREQUENCY DRIVES

PART 1-GENERAL

1.1 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.
- B. The drive manufacturer shall supply the drive and all necessary options as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

1.1 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - 2. Underwriters laboratories
 - a) UL508C
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a) ICS 7.0, AC Adjustable Speed Drives
 - 4. IEC 16800 Parts 1 and 2
 - 5. National Electric Code (NEC)
 - a) NEC 430.120, Adjustable-Speed Drive Systems
 - 6. International Building Code (IBC)
 - a) IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156
- B. Qualifications:
 - 1. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
 - 2. CE Mark – The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
 - 3. The entire VFD enclosure, including the bypass shall be seismically certified and labeled as such in accordance with the 2006 International Building Code (IBC):
 - a) VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
 - b) Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.

- c) Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion.
- 4. Acceptable Manufactures
 - a) ABB ACH Series.
 - b) Alternate manufacturer's requests must be submitted in writing to the Engineer for approval at least 20 working days prior to bid. Approval does not relieve the supplier of specification requirements.
- 5. The VFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering VFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID number. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.1 SUBMITTALS

- A. Submittals shall include the following information:
 - 1. Outline dimensions, conduit entry locations and weight.
 - 2. Customer connection and power wiring diagrams.
 - 3. Complete technical product description include a complete list of options provided. Any portions of this specification not meet must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.
 - 4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - a) The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 – PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

- A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
- 1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 50⁰ C (32 to 122⁰ F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can

only operate at 40° C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.

2. Enclosure shall be rated UL Type 1 and shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. NEMA only type 1 enclosures are not acceptable (must be UL Type 1).

B. Standard Features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus)

- reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add an AC line reactor.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
 11. The VFD shall include a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
 12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
 13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload
 14. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
 15. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
 16. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set

- point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
4. Two (2) programmable analog inputs shall accept current or voltage signals.
 5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
 6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.
 7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
 8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety input status shall also be transmitted over the serial communications bus.
 9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
 10. Seven (7) programmable preset speeds.
 11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
 12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
 14. The VFD shall include password protection against parameter changes.
- D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:

1. Start-up assistant
 2. Parameter assistants
 - a. PID assistant
 - b. Reference assistant
 - c. I/O assistant
 - d. Serial communications assistant
 - e. Option module assistant
 - f. Panel display assistant
 - g. Low noise set-up assistant
 3. Maintenance assistant
 4. Troubleshooting assistant
 5. Drive optimizer assistants
- E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
- Output Frequency
 - Motor Speed (RPM, %, or Engineering units)
 - Motor Current
 - Motor Torque
 - Motor Power (kW)
 - DC Bus Voltage
 - Output Voltage
- F. Serial Communications
1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet). Use of non-certified protocols is not allowed.
 2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - a. Data Sharing – Read Property – B.
 - b. Data Sharing – Write Property – B.
 - c. Device Management – Dynamic Device Binding (Who-Is; I-Am).
 - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - e. Device Management – Communication Control – B.
 3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
 4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC

- shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
- G. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
- H. All VFD's through 100 HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.
- I. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor per section 2.01K below.
- J. BYPASS CONTROLLER
1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.
2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
4. The drive and bypass package shall be seismic certified and labeled to the IBC:
- a. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.

6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
7. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
10. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include ModBus; Johnson Controls N2; Siemens Building Technologies FLN (P1); and BACnet.
11. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad "Hand" or "Auto" selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
12. The bypass serial communications shall allow control of the bypass' digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass' digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass' digital inputs shall be capable of being monitored by the DDC system.
13. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.

14. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
15. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman's override / smoke control mode.
16. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.
17. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
18. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
 - a. Over current
 - b. Over voltage
 - c. Under voltage
 - d. Loss of analog input
19. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector
 - c. Bypass mode selector
 - d. Bypass fault reset
20. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
21. The bypass shall include a supervisory control mode. In this bypass mode, the bypass shall monitor the value of the VFD's analog input (feedback). This feedback value is used to control the bypass contactor on and off state. The supervisory mode shall allow the user to maintain hysteresis control over applications such as cooling towers and booster pumps even with the VFD out of service.
22. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include

- “FireStat”, “FreezStat”, “Over pressure” and “Low suction”. The user shall also be able to determine which of the four (4) safety contacts is open over the serial communications connection.
23. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer the motor from VFD mode to Bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. The Smoke Control Override Mode action is not programmable and will always function as described in the bypass User’s Manual documentation. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
24. Fireman’s Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge some digital inputs, all digital inputs, ignore digital inputs or any combination of the above. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for “Run-to-Destruction”. The user may also force the unit into Override 2 via the serial communications link.
25. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.02 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.03 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at

both the specifying and installation locations. A toll free 24/365 technical support line shall be available.

- B. A computer based training CD or 8-hour professionally generated video (VCR format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the VFD, bypass and serial communication.

3.04 WARRANTY

- A. The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

End of Section

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Single-wall rectangular ducts and fittings.
- 2. Sheet metal materials.
- 3. Duct liner.
- 4. Sealants and gaskets.
- 5. Hangers and supports.
- 6. Seismic-restraint devices.

- B. Related Sections:

- 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
- 2. Division 23 Section "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
- 3. Division 23 Section "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
- 4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
 - 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
 - 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.

2. Sealants and gaskets.
3. Seismic-restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.

- c. Speakers.
- d. Sprinklers.
- e. Access panels.
- f. Perimeter moldings.

1.6 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: Black
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Insulation Pins and Washers:

1. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 3. Butt transverse joints without gaps, and coat joint with adhesive.
 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
 7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
 2. Type: S.
 3. Grade: NS.
 4. Class: 25.
 5. Use: O.
 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2.6 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.
 - 5. Loos & Co.; Cableware Division.
 - 6. Mason Industries.
 - 7. TOLCO; a brand of NIBCO INC.
 - 8. Unistrut Corporation; Tyco International, Ltd.
- B. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- J. Where ducts pass through fire-rated interior partitions, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
 - 2. Conditioned Space, Return-Air Ducts: Seal Class C.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 - 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

- a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Heat Pumps and Terminal Units:

- a. Pressure Class: Positive 1-inch wg.
- b. Minimum SMACNA Seal Class: B
- c. SMACNA Leakage Class for Rectangular: 12
- d. SMACNA Leakage Class for Round and Flat Oval: 12

2. Ducts Connected to Constant-Volume Air-Handling Units <Insert equipment>:

- a. Pressure Class: Positive [2-inch wg (500 Pa)] [3-inch wg (750 Pa)] <Insert value>.
- b. Minimum SMACNA Seal Class: [A] [B].
- c. SMACNA Leakage Class for Rectangular: [6] [12] [24] <Insert value>.
- d. SMACNA Leakage Class for Round and Flat Oval: [6] [12] [24] <Insert value>.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units <Insert equipment>:

- a. Pressure Class: Positive [3-inch wg (750 Pa)] [4-inch wg (1000 Pa)] <Insert value>.
- b. Minimum SMACNA Seal Class: [A] [B].
- c. SMACNA Leakage Class for Rectangular: [3] [6] <Insert value>.
- d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] <Insert value>.

C. Return Ducts:

1. Ducts Connected to Return Air Shafts:

- a. Pressure Class: Positive or negative 1-inch wg.
- b. Minimum SMACNA Seal Class: B
- c. SMACNA Leakage Class for Rectangular: 12.

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

E. Liner:

1. Supply Air Ducts: Flexible elastomeric, 1 inch thick.
2. Return Air Ducts: Flexible elastomeric 1 inch thick.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm (5 m/s) or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm (7.6 m/s) or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

- 3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
- b. Round Elbows, [12 Inches (305 mm)] <Insert dimension> and Smaller in Diameter: Stamped or pleated.

G. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
 - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Control dampers.
 - 3. Fire dampers.
 - 4. Smoke dampers.
 - 5. Combination fire and smoke dampers.
 - 6. Turning vanes.
 - 7. Duct-mounted access doors.
 - 8. Flexible connectors.
 - 9. Flexible ducts.
- B. Related Requirements:
 - 1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
 - 2. Division 28 Section "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.
 - 3. Division 28 Section "Zoned (DC-Loop) Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. LEED Submittals:
 - 1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: [G60 (Z180)] [G90 (Z275)].
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Pottorff.
 - f. Ruskin Company.
 - g. Trox USA Inc.
 - h. Vent Products Company, Inc.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating[, with linkage outside airstream,] and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
 - a. 16-gauge galvanized steel.
 - b. Mitered and welded corners.
 - c. flangeless frames for installing in ducts.
6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.
7. Blade Axles: Galvanized steel.
8. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Vinyl.
10. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.4 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. Lloyd Industries, Inc.
 6. McGill AirFlow LLC.
 7. Metal Form Manufacturing, Inc.
 8. Nailor Industries Inc.
 9. NCA Manufacturing, Inc.
 10. Pottorff.
 11. Ruskin Company.
 12. Vent Products Company, Inc.
 13. Young Regulator Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 1. 16 gauge galvanized sheet steel.

D. Blades:

1. Multiple blade with maximum blade width of 8 inches.
2. Opposed-blade design.
3. Galvanized-steel
4. Blade Edging: Closed-cell neoprene

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. Nailor Industries Inc.
6. NCA Manufacturing, Inc.
7. Pottorff.
8. Prefco; Perfect Air Control, Inc.
9. Ruskin Company.
10. Vent Products Company, Inc.
11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.05 –inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical.

H. Blades: Roll-formed, interlocking, 0.024-inch- thick, galvanized sheet steel. Not all manufacturers use blade locks for horizontal units.

- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with mechanically attached corners and mounting flange.
- A. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel.
- B. Leakage: Class I.
- C. Rated pressure and velocity to exceed design airflow conditions.
- D. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- E. Damper Motors: Modulating action.
- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf
 - 5. Electrical Connection: 115 V, single phase, 60 Hz.
- B. Accessories:
 - 1. Test and reset switches, damper mounted.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. Pottorff.
 - 6. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg and 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with mechanically attached corners and mounting flange.
- F. Heat-Responsive Device: Electric resettable device and switch package, factory installed, rated.
- G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel.
- H. Leakage: Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, 0.039-inch- thick, galvanized sheet steel; length to suit wall or floor application.
- K. Master control panel for use in dynamic smoke-management systems.
- L. Damper Motors: Modulating action.
- M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf
 - 5. Electrical Connection: 115 V, single phase, 60 Hz.
- N. Accessories:

1. Test and reset switches, damper mounted.

2.8 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Nexus PDQ; Division of Shilco Holdings Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.9 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. METALAIRE, Inc.
 5. SEMCO Incorporated.
 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Cesco Products; a division of Mestek, Inc.
 3. Ductmate Industries, Inc.
 4. Elgen Manufacturing.
 5. Flexmaster U.S.A., Inc.
 6. Greenheck Fan Corporation.
 7. McGill AirFlow LLC.
 8. Nailor Industries Inc.

9. Pottorff.
 10. Ventfabrics, Inc.
 11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Elgen Manufacturing.
 4. Ventfabrics, Inc.
 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

2.12 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylenevapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: 4.2.
- C. Flexible Duct Connectors:
1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install fire and smoke dampers according to UL listing.
- F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 2. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 3. Control devices requiring inspection.
 4. Elsewhere as indicated.
- G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches
2. Two-Hand Access: 12 by 6 inches
3. Head and Hand Access: 18 by 10 inches
4. Head and Shoulders Access: 21 by 14 inches
5. Body Access: 25 by 14 inches
6. Body plus Ladder Access: 25 by 17 inches

I. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. Connect terminal units to supply ducts with maximum 48-inch lengths of flexible duct. Do not use flexible ducts to change directions.

L. Connect flexible ducts to metal ducts with draw bands.

M. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. Air Terminal Units and accessories.

B. Related Sections:

1. Common Work results for HVAC: Section 23 05 00.

1.2 SUBMITTALS

- A. Submit product data for each product specified in this section.
- B. See 23 05 00 for additional general requirements.
- C. Submit schedule showing air pressure loss at maximum cfm used on drawings.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Conform to NFPA 90A.
- B. Test air terminal units in accordance with ARI Standard 880, Appendix A.

PART 2 - PRODUCTS

2.1 AIR TERMINAL UNITS (TU)

- A. Manufacturers: Products of the following manufacturers, provided they comply with requirements of the contract documents and are participating members in the ARI 880 Certification Program, will be among those considered acceptable:
 1. E.H. Price.
 2. Titus Products Division/Philips Industries, Inc.
 3. The Trane Company.
- B. Terminal Unit Controls: The following Controls will be provided under Section 23 09 00. Factory installation of controls will be coordinated by Section 23 09 00.
 1. Direct digital controller for pressure independent primary air control (DDC).
 2. Damper actuator.
 3. Transformer: Where electric heaters are used, transformers provided with the electric heater may be used for control power. When unit does not have a heater, control voltage power source shall be provided by Section 23 09 00.
 4. Air flow transducer.

- C. Air terminal unit manufacturer shall provide the following:
1. Primary air control damper.
 2. Multipoint Velocity sensor: This Section shall provide velocity pressure/flow CFM curves to Section 23 09 00 vendor to enable proper CFM calculation.
 3. Electric heating coil.
- D. Air terminal unit manufacturer shall mount all components furnished by Division 23 09 00 including the following:
1. Damper actuators.
 2. Controllers.
- E. Primary Air Control Damper in Insulated Metal Casing: Volume regulation within 5 percent, between 0.5 and 6.0 inches static pressure, water gage. The primary air device shall provide shut-off with a leakage rate not over 2% at 1" S.P. or 4% of the rated CFM at 3" S.P. for 1,800 CFM and smaller units, and not over 6% at 3" S.P. for larger units.
- F. Unit shall be double-wall construction with 1" thick dual density glass fiber insulation.
- G. Housing: 20 gauge minimum galvanized sheet metal. (Seal all joints.)
- H. The sound ratings are a requirement for submission. Selected size units as furnished on this project shall be tested in an independent testing laboratory. Unit maximum radiated sound power levels as published by manufacturer shall not exceed the following with 1.5 inch inlet static pressure and design primary airflow (0.25 inch downstream static pressure):

Sound Power Levels					
Octave		CFM			
Band					
(Hz)		600	1000	1500	1800
125		63	64	65	69
250		57	60	62	64
500		51	52	57	56
1000		45	48	52	51
2000		44	49	52	51

- I. Electric Heaters:
1. Heaters are to be listed by Underwriters Laboratories and shall meet the requirements of the National Electrical Code.
 2. Heaters shall have 80% nickel, 20% chromium resistance coils. Coils shall be supported by ceramic bushings recessed and staked into embossed openings in supporting brackets. Coils shall be machine-crimped into stainless steel terminals which are insulated with high temperature phenolic or ceramic bushings.
 3. Over temperature Protection: All heaters shall be furnished with one disk type, automatic reset thermal cutout for primary over temperature protection. All heaters shall also be furnished with a disk type, load-carrying manual reset thermal cutout factory wired in series with each heater stage for secondary protection.
 4. Heaters shall be rated for the voltage, phase and number of heating stages indicated in the schedule. All internal wiring shall be suitable for 105 degree C. Fuses shall be provided in all heaters. Heaters scheduled for voltages above 120V shall have control transformer with fused primary and secondary.
 5. Built-in and wired factory installed controls shall include thermal cutouts, airflow switch, separate switch for each stage and built-in unfused disconnect switch. Two-stage switches are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. See Section 23 05 00 for additional general requirements.
- C. Install all air terminal units level, and maintain clearances for normal service and maintenance as recommended by the manufacturer.
- D. Support all air terminal units from structure. Do not support from adjacent work.

END OF SECTION 23 36 00

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SECTION 238146 - WATER-SOURCE HEAT PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of water-source heat pumps:
 - 1. Concealed horizontal or vertical units, 6 tons and smaller.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each model.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For water-source heat pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. ASHRAE Compliance:
 - 1. ASHRAE 15.
 - 2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- E. Comply with NFPA 70.
- F. Comply with safety requirements in UL 484 for assembly of free-delivery water-source heat pumps.
- G. Comply with safety requirements in UL 1995 for duct-system connections.

1.6 COORDINATION

- A. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, refrigeration components.
 - 2. Warranty Period: Five (5) years from date of Substantial Completion. Includes refrigeration circuit, coils, reversing valve, expansion valve and compressor for a total of 5 years

PART 2 - PRODUCTS

2.1 CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS (21 kW) AND SMALLER

- A. Manufacturers:
 - 1. Addison Products Company.
 - 2. Bard Manufacturing Company.
 - 3. Carrier Corporation.
 - 4. ClimateMaster, Inc.
 - 5. FHP Manufacturing Inc.
 - 6. Hydro-Temp Corporation, Inc.
 - 7. Mammoth Inc.
 - 8. McQuay International.
 - 9. Trane.
 - 10. Water Furnace International, Inc.
- B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.
- C. Cabinet and Chassis: Galvanized-steel casing with the following features:
 - 1. Access panel for access and maintenance of internal components.
 - 2. Knockouts for electrical and piping connections.
 - 3. Flanged duct connections.
 - 4. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with UL 181.

5. Condensate Drainage: stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Fan: Direct driven, centrifugal, with multispeed motor resiliently mounted in fan inlet.
1. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 2. Motor: Multispeed, permanently lubricated, permanent split capacitor motor.
- E. Water Circuit:
1. Refrigerant-to-Water Heat Exchangers:
 - a. Coaxial heat exchangers with cupronickel water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube leak tested to 450 psig (3102 kPa) on refrigerant side and 400 psig (2758 kPa) on water side. Factory- mount heat exchanger in unit on resilient rubber vibration isolators.
 2. Motorized Water Valve: Stop water flow through the unit when compressor is off.
- F. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig (3102 kPa).
- G. Refrigerant Circuit Components:
1. Sealed Refrigerant Circuit: Charge with R-410A refrigerant.
 2. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
 3. Charging Connections: Service fittings on suction and liquid for charging and testing.
 4. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
 5. Compressor: Hermetic **scroll** compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:
 - a. Antirecycle timer.
 - b. High-pressure cutout.
 - c. Low-pressure cutout or loss of charge switch.
 - d. Internal thermal-overload protection.
 - e. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
 6. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
 7. Pipe Insulation: Refrigerant minimum 3/8-inch- thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E 84.
- H. Filters: Disposable, glass-fiber, flat type, 1 inch thick, treated with adhesive, and having a minimum of 80 percent arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value of 5 according to ASHRAE 52.2.
- I. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Controls for HVAC" and "Sequence of Operations for HVAC Controls."
- J. Controls:

1. Basic Unit Controls:
 - a. Low- and high-voltage protection.
 - b. Overcurrent protection for compressor and fan motor.
 - c. Random time delay, three to ten seconds, start on power up.
 - d. Time delay override for servicing.
 - e. Control voltage transformer.
 2. BAS interface requirements as further described in Division 23 Sections "Instrumentation and Controls for HVAC" and "Sequence of Operations for HVAC Controls."
 - a. Interface relay for scheduled operation.
 - b. Interface relay to provide indication of fault at central workstation.
 - c. Provide BAC-net interface for the following functions:
 - 1) Set-point adjustment for set points identified in this Section.
 - 2) Start/stop and operating status of heat-pump unit.
 - 3) Data inquiry to include supply air, room air temperature and humidity, and entering-water temperature.
 - 4) Occupied and unoccupied schedules
- K. Electrical Connection: Single electrical connection with fused disconnect.
- L. Capacities and Characteristics: see equipment schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of water-source heat pumps.
- B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduit before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting: Install water-source heat pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of water-source heat pump unit.
 1. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 2. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 - 1. Connect supply and return hydronic piping to heat pump with hose kits.
 - 2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
 - 1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
- C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 CLEANING

- A. Replace filters used during construction prior to air balance or substantial completion.
- B. After completing installation of exposed, factory-finished water-source heat pumps, inspect exposed finishes and repair damaged finishes.

END OF SECTION 23 81 46

SECTION 260100 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Submittal Requirements.
 - 2. Plywood backboards.

1.2 RELATED SECTIONS

- A. Electrical requirements described in this Section apply to all Sections of Division 26. Division 26 specification sections are interrelated and what is called for by one section shall be deemed as required by the other sections. An individual specification section that lists other specific sections in RELATED SECTIONS, is done for the convenience of the reader and is not to be construed as the only related sections.
- B. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to all sections of Division 26.

1.3 DEFINITIONS

- A. Refer to Division 01 for definitions used in the Contract Documents. Some of the following definitions are duplicated from that reference for a specific purpose or are additions applicable to this Division.
 - 1. Provide: Furnish, install and connect.
 - 2. Wiring: Wire or cable installed in conduit with all required boxes, fittings, connectors, etc.
 - 3. Work: Materials completely installed, including the labor involved.
 - 4. Conduit: Rigid galvanized steel conduit (RGSC), electrical metallic tubing (EMT), intermediate metal conduit (IMC), rigid non-metal conduit (RNC), or flexible metal conduit (FMC).
 - 5. Branch Circuit: The circuit conductors between the final over current device protecting the circuit and the load(s) or outlet(s).
 - 6. Feeder: All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch circuit over current device(s).
 - 7. Where shown or where indicated: Reference to Drawing(s), item or items.
 - 8. Or equal: Shall mean equivalent as approved by the Architect or Engineer.

1.4 SYSTEM DESCRIPTION

- A. The extent of Division 26 work shall be as shown on the Electrical Drawings. This Division includes all the electrical work except that work specifically designated as being specified or required by other Divisions. Work is to include all labor and material necessary for the complete electrical installation and proper operation of all electrical systems including but not limited to equipment associated with the HVAC, Fire Protection, Fire Alarm and Plumbing Systems.
- B. Drawings: The Electrical Drawings are diagrammatic in nature except where specific dimensions, or specific details, are shown. Refer to other project drawings for exact locations of equipment, building dimensions, Architectural details and conditions affecting the electrical work.

1.5 SUBMITTALS

- A. General: Unless otherwise indicated, all submittals shall be made in accordance with requirements as specified herein and in Division 01 Section "Submittals".
- B. All material lists and shop drawing submittals shall include a stamped indication signifying that the submittals have been previously reviewed for compliance with the Contract Documents, that all coordination required prior to field installation has occurred and that the material being submitted is approved for installation. The stamped indication shall include the name of the Contracting Firm, the date of the review and the signature of the Contractor. The Engineer will not review the shop drawing submittals without the Contractors stamped approval on the shop drawings. The responsibility of complying with the Contract Documents shall not be relieved by the Engineer's review and comments. The Engineer's review requires not less than two (2) weeks from date the shop drawings are received by the Engineer. Submittals for equipment specified in each Section, with the exception of samples, shall be loose-leaf pages, bound into a 3-ring binder and submitted as a complete package. The submittal may be included in more than one volume. However, the submittal shall be separated into groups of types of equipment as follows:
 - 1. Group I - Conduit, Boxes and Devices:
 - a. Wall Switches
 - b. Receptacles
 - c. Cover plates
 - d. Poke-Thru Service Fittings
 - e. Fire Protection Seals, UL Assembly Details
 - 2. Group II - Switchgear:
 - a. Lighting and Appliance Branch Circuit Panelboards
 - b. Transient Voltage Surge Suppressors
 - 3. Group III - Lighting:
 - a. Lighting Fixtures
 - b. Ballasts
 - c. Lamps
 - d. Lighting Control Systems

- C. Product Data: Manufacturers technical product literature, including specifications and installation instructions for each component and system as listed in Products, Part 2, of each section.
- D. Shop Drawings: Dimensioned drawings and layouts showing location of system components, accessories and secondary systems. Include wiring diagrams, connections and special installation details.
- E. Coordination Drawings: Detailed layout drawings showing primary elements, components and systems of electrical equipment and materials in relationship with other building components.
 - 1. Indicate clearances for servicing and maintaining equipment.
 - 2. Indicate locations where space is limited and sequencing and coordination will affect efficient installation of the Work.
- F. Quality Control Submittals: Provide the following for record:
 - 1. Test Reports.
 - 2. Certificates.
 - 3. Manufacturers Instructions.
 - 4. Manufacturers Field Reports.
- G. Contract Close-out Submittals: Provide tab pages with metal or plastic reinforced holes to separate each major item or closely related group of items with typed item names on the tabs. Supply a table of contents at the beginning of each volume listing all items, the manufacturers and the name, address and phone number of the nearest authorized service representative. In addition to operation, maintenance and lubrication instructions, the manuals shall include the following:
 - 1. Parts lists.
 - 2. Power and control wiring diagrams.
 - 3. Elementary or schematic wiring diagrams.
 - 4. Manufacturers recommended tightening torque for connections where applicable.
- H. Project Record Documents: Furnish project record documents in accordance with General Conditions and Division 01. Include marked up as-built drawings indicating proper circuit numbers, conduit homeruns, branch conduit runs, and other such pertinent data. Mark the actual installed depths of all buried electrical conduit or cable and show the measured horizontal distance from permanent construction, such as building walls. Especially mark where any riser conduit occurs. Include the following:
 - 1. "As-built" conduit layout diagrams, including wire color code and/or tag number.
 - 2. Complete "as-built" wiring diagrams.
 - 3. Detailed catalog data on all installed system components.
 - 4. Copy of the test reports described elsewhere.
- I. Operation and maintenance data warranty: Provide three copies at time of Final Completion in accordance with the General Conditions and Division One. Use multiple binders if a single binder would exceed 2-1/2" in thickness. Arrange the data in the same sequence as the specification Section. Delete or mark through extraneous data. Before final acceptance of work, the Contractor shall deliver the composite "Operating and Shop Maintenance Manual." Each manual shall contain, but not be limited to:
 - 1. A statement of guarantee, including date of termination and name and phone number of the person to be called in event of equipment failure.

2. Individual factory-issued manuals containing all technical information on each piece of equipment installed. In the event such manuals are not obtainable from the factory, it shall be the responsibility of the Contractor to compile and include them. Advertising brochures or operational instructions shall not be used in lieu of the required technical manuals.

1.6 SUBSTITUTIONS

- A. Throughout the Specifications, types of material may be specified by manufacturer's name and catalog number in order to establish standards of quality and performance. Where one or more manufacturers are listed for a product, without the words "or equal", provide the equipment of one of the manufacturers listed. Where one or more manufacturers are listed followed by the words "or equal", provide the product of one of the manufacturers listed, or request a substitution of a product of equal quality, performance and function as specified in Division 01. However, the burden is upon the requester to prove such equivalence. He must request the Architect's approval (in writing) to substitute such item for the specified item, with supporting data (and samples, if required) to permit a fair evaluation of the proposed substitute with respect to quality, serviceability, warranty and cost.
- B. When a substitute item is proposed, all costs associated with changes to incorporate the substituted item shall be borne by the Contractor without incurring additions to the Contract.

1.7 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall have minimum 5 years experience in the manufacture of the indicated products.
- B. Regulatory Requirements: All products (including equipment) furnished for the electrical installation shall bear the Listing Mark or Classification Marking (label) of UL where such marking is available or other approved testing agency. Products which are not listed will not be acceptable.
- C. The work under Division 26 shall comply with relevant portions of the following. The most stringent shall apply where a code conflict occurs.
 1. Federal Occupational Safety and Health Act.
 2. Americans with Disabilities Act (ADA).
 3. State of Georgia Accessibility Code.
 4. NFPA-13 Installation of Sprinkler Systems.
 5. NFPA-70 National Electrical Code (NEC), 2011 with Georgia Amendments.
 6. NFPA-72 National Fire Alarm Code.
 7. NFPA-90A Installation of Air Conditioning and Ventilation Systems.
 8. NFPA-101 Life Safety Code.
 9. ASME-A17.1 Elevator Code.
 10. ASHRAE Standard 90.1 - 2007.
- D. Where different sections of any of the aforementioned codes and regulations, or the Contract Documents, require different materials, methods of construction or other requirements, the most restrictive shall govern. In any conflict between a general provision and a special provision, the special provision shall govern. In case of differences between the drawings and the specifications, or where the drawings and specifications are not clear, the higher cost alternative shall be included in the contract and the subject shall be referred to the Architect for clarification and instructions.

1.8 DELIVERY STORAGE AND HANDLING

- A. Packing and Shipping: All materials shall be packed to prevent damage during shipping. Packing shall include plastic rap and crating. Coordinate shipping of items to the jobsite to prevent exposure to weather. Equipment will not be permitted to be stored outside.
- B. Acceptance at Site: Receive delivery of electrical equipment and protect from the weather at all times during storage and construction.
- C. Storage and Protection: Provide offsite storage of equipment if building is not totally enclosed and ready to accept equipment. Manufacturer's recommendations with regard to storage and protection shall be followed. Should any apparatus be subjected to possible damage by water, it shall be replaced with new apparatus, or at the direction of the Architect, thoroughly dried and put through a dielectric test to ascertain the suitability of the apparatus, or it shall be replaced, in either case without incurring additions to the Contract.

1.9 PROJECT / SITE CONDITIONS

- A. Before ordering any equipment, the physical size of all equipment shall be checked to properly fit the allotted spaces shown, and to satisfy all NEC required clearances.
- B. Environmental Requirements: Comply with manufacturers requirements for environmental conditions during shipping, storage, installation, testing and operation. Maintain manufacturers recommended ambient conditions such as temperature, humidity, altitude, ventilation, etc.
- C. Existing Conditions: Attention is called to the fact that this work is a renovation within an existing facility. Care must be taken not to interrupt the operation of the existing facility, nor any existing systems, except as directed by the Contract Documents and in coordination with the Owner. Included in this work is the requirement to visit the site, to review the existing conditions, and to become specifically familiar with the modifications and demolition work necessary. Failure to conduct the survey and any lack of familiarization with the existing conditions will not constitute grounds for consideration of additions to the Contract after award nor during construction. It must be understood that this work includes demolition and removal from the site of any materials and equipment rendered useless by this renovation. Any existing material or equipment specified to be salvaged shall be turned over to the Owner. When this work is completed, all existing systems shall operate and function in the same manner as prior to the renovation, completely integrated with any additions to the systems as indicated and as specified.
- D. Field Measurements: Measure and confirm field conditions prior to installation of equipment. Notify Architect and Owner within 24 hours of any discrepancy or code violations caused by field conditions.

1.10 SEQUENCING, SCHEDULING AND COORDINATION

- A. Work shall be coordinated to preclude interference between the work of different trades and to ensure necessary clearances at crossovers and equipment. Work requiring necessarily fixed locations (e.g., piping with required slopes, lighting fixtures in ceilings, etc.) shall take precedence over work not requiring such fixed locations. Furnish all labor, materials and incidental elements, such as junction and pull boxes, fittings, pull wires, connectors, support materials, fuses, lamps and labels, along with other necessary requirements to install, connect, start-up and result in complete and working systems in accordance with the requirements of the Contract Documents.

- B. Provide all wiring, connectors, fittings and all other accessories necessary for the complete installation of, and final connections to, equipment furnished under other Divisions and/or by the Owner where shown. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from contemplated design, notify the Architect and/or Engineer before proceeding with the installation. Attention is called to the fact that certain features of control, other functions, or systems may be specified in this Division by performance, and as such, all elements of wiring or other materials and devices required for the complete installation may not be shown.
- C. Coordinate electrical equipment and materials installation with other building components.
- D. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- E. Cutting and patching of structural components to accommodate the installation of electrical equipment and materials will not be allowed unless approved in writing by the Structural Engineer.

1.11 PERMITS/LICENSES/FEES

- A. Obtain all permits and licenses, and pay all fees as required for execution of the Contract. Arrange for necessary inspections required by the city, county, territory and other authorities having jurisdiction, and present certificates of approval to the Owner.

1.12 WARRANTY

- A. All work specified in Division 26 shall be guaranteed to be free from defects in material and workmanship for a period of one year or longer as required from date of final acceptance by the Owner. Lamps for lighting fixtures or indicating devices, which fail to operate due to normal mortality rates, are excluded from this guarantee unless a part of a normal manufacturers' guarantee of total life for a lamp and fixture system.
- B. Fixture or device damage resulting from a lamp failure shall fall within the required guarantee.
- C. During this guarantee period, all defects in materials and workmanship shall be corrected without incurring additions to the Contract. The correction shall include all required cutting, patching, repainting, or other work involved, including repair or restoration of any damaged sections or parts of the premises resulting from any fault included in the guarantee.
- D. In addition to this general guarantee, present to the Owner any other guarantees or warranties from equipment or system manufacturers. These supplemental guarantees or warranties shall not invalidate the general guarantee.
- E. The one-year warranty period shall commence upon system acceptance by the Owner.
- F. In the event that defects in materials or workmanship are encountered during the warranty period, the Contractor shall provide all materials and labor required for prompt and proper correction of such defects at no additional cost to the Owner.

1.13 TEMPORARY LIGHT AND POWER

- A. Provide temporary, construction area electrical service at 208/120V, 3-phase, 4-wire. Branch circuit requirements for building temporary lighting and power as follows:
 - 1. Sufficient wiring, outlets and lamps shall be installed to insure proper lighting in accordance with OSHA, state and municipal codes.
- B. Provide all necessary transformers, cables, panelboards, ground fault devices, switches and accessories required by the temporary light and power installation.
- C. Install and maintain a feeder, or feeders, of sufficient capacity for the requirements of all areas. Also provide a sufficient number of outlets, located at convenient points throughout the construction area.
- D. Remove all temporary service equipment, wiring and accessories after they have served their purpose.

PART 2 - PRODUCTS

2.1 GENERAL MATERIALS AND WORKMANSHIP

- A. Materials and apparatus required for the work shall be new, of first-class quality, and shall be furnished, delivered, erected, connected, finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces in compliance with all requirements.
- B. Manufacturer's catalog numbers listed are not necessarily complete. Products provided shall be a standard product which has a history of successful installation and operation for a minimum period of two years. Prototype or custom made equipment is not acceptable unless so specified.
- C. Manufacturer's instructions shall be obtained and used for the installation of all equipment and devices where such manufacturers' instructions are available.

2.2 PLYWOOD BACKBOARDS

- A. 3/4" thick, softwood face plywood backboard with equipment mounting sides "finish grade", and all sides and edges painted with at least two coats of fire retardant black paint.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Applicable provisions of the latest edition of NECA 1 "Standard Practices for Good Workmanship in Electrical Construction", published by the National Electrical Contractors Association (NECA) shall set the standard for installation of materials and equipment and for workmanship. Install all materials in a neat and orderly manner. Cover conduits, boxes, cabinets, and other enclosures with plastic covers or caps to prevent entrance of plaster, concrete, or other debris when work is not being done. Materials and equipment shall be installed using tools and equipment designed for the particular application.

- B. Manufacturer's instructions shall be obtained and used for the installation of all equipment and devices where such manufacturer's instructions are available.

3.2 PHASE ROTATION

- A. The phase rotation (A, B, C) of all service entrance, distribution and branch circuit installations shall be maintained throughout the entire project.
- B. Test the phase rotation at all distribution equipment to verify compliance.
- C. Backboard sizes shall be large enough to accommodate the equipment or devices to be mounted or sized as indicated. Backboard shall be attached to the wall or metal frame with not less than four bolts.

3.3 EQUIPMENT ACCESS

- A. Install equipment so it is readily accessible for maintenance and operation. Provide access doors where required.

3.4 FIELD QUALITY CONTROL

- A. Tests and Reports: All systems and equipment shall be extensively tested by the electrical contractor prior to final inspection. Each test shall be signed off by the Owner in writing.
- B. At the time of the final inspection or at such time as part of the system may be completed, all electrical systems shall be tested, in the presence of the Architect, for compliance with the Contract Documents. Furnish all necessary personnel and equipment, such as measuring instruments for current, voltage and resistance, and ladders, two-way radios, lights, etc. to assist the Owner in conducting the tests. Authorized representatives of the manufacturer of specialty equipment or systems shall be present during the tests to demonstrate compliance with the Contract Documents.
- C. Perform operational tests on all systems. Every system test report shall be performed according to the manufacturers instruction and shall include the following documentation, which shall be delivered to the Owner or a representative upon final acceptance of the system:
 - 1. Summary of Project.
 - 2. A complete list of equipment tested.
 - 3. Description of test.
 - 4. Indication that all equipment is properly installed and functions in conformance with the specifications.
 - 5. Tests results of equipment as applicable.
 - 6. Conclusions and recommendations
 - 7. Appendix, including appropriate test forms.
 - 8. List of test equipment used.
 - 9. Technician's name, certificate number and date.
- D. Final tests and inspection shall be held in the presence of the Owner's representatives and to their satisfaction. The Contractor shall supply personnel and required auxiliary equipment for this test.
- E. The complete system shall be tested to ensure that it is operating properly.

3.5 TEST INSTRUMENT CALIBRATION

- A. Calibrate instruments in accordance with the following frequency schedule:
 - 1. Field Instruments: Analog - 6 months maximum. Digital - 12 months maximum.
 - 2. Laboratory Instruments - 12 months maximum.
 - 3. Leased Specialty Equipment - 12 months.
- B. Dated calibration labels shall be visible on all test equipment.
- C. Records must be kept up to date which show date and results of instruments calibrated or tested.
- D. Maintain an up-to-date instrument calibration instruction procedure.
- E. Calibrating standard shall be of a higher accuracy than that of the instrument tested.

3.6 DEMONSTRATION

- A. All training shall be scheduled and take place in a location and date agreed upon by the Owner. A course outline of the training program shall be forwarded to the Architect for delivery to the Owner at least three weeks in advance of presentation of each course. All training hours shall take place between the hours of 8:00 AM to 6:00 PM, Monday through Friday.
- B. Maintenance Training:
 - 1. During the course of the installation, several persons will be designated by the Owner for receiving maintenance training.
 - 2. The maintenance training courses shall include operation, troubleshooting using both test hardware and diagnostic programs, and failure repair of actual system hardware. Servicing personnel shall receive detailed instructions in principles of operation, set-up, adjustments and routine preventive maintenance, diagnosis and corrective repair of all system components. The training of service personnel shall be completed prior to substantial completion and systems acceptance by the Owner. Provide two, eight (8) hour maintenance training sessions.
 - 3. Contractor shall provide proposed course outlines.

3.7 TRAINING AND TESTING SCHEDULE

- A. Provide a schedule detailing the outline, date and duration of all training and testing no later than 60 days after the award of contract. Submit all dates to the Architect for approval. Coordinate all dates with Owner, Architect, Engineer, Manufacturers, and all other parties involved.
- B. The Owner reserves the right to revise the schedule without incurring delay or additional cost to the contract.

3.8 PROTECTION

- A. Protect all electrical equipment from damage at all times. Cover and enclose all equipment to protect from damage by water or moisture.

3.9 ADJUSTMENT

- A. Calibrate and adjust all equipment in accordance with manufacturers' instructions. Adjust and set all circuit breakers and relays in accordance with the coordination study when required by other specification sections.

3.10 CLEANING

- A. At completion of the work, clean all elements of the electrical system so that all markings deteriorating the original finish appearance are removed. All lighting fixtures and lenses shall be cleaned inside and out. All lamps shall be left clear of dust, smudges and grime.
- B. Additionally, examine the interiors of panelboards, cabinets, lighting fixtures, boxes, and like components where conduit and/or wire connections have been made, and all resulting wire ends, insulation cuttings, knock-out plugs, metal filings and any other construction debris shall be removed so that interiors and exteriors are clean.

END OF SECTION 16010

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 SUBMITTALS

- A. Product Data: Fire protection seals, U.L. assembly details.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wire ways, cable trays, and bus ways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in concrete, masonry walls, and other structural components.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of fire stopping specified in Division 07 Section "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wire ways, cable trays, or bus ways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with fire stop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors **2 inches (50 mm)** above finished floor level.
- G. Size pipe sleeves to provide **1/4-inch (6.4-mm)** annular clear space between sleeve and raceway or cable, except where indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with fire stop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.3 FIRESTOPPING

- A. Apply fire stopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.

- B. Copper Conductors: Comply with NEMA WC 70 for Types THHN-THWN.
 - 1. Grounded (neutral) conductors sizes #6 AWG or smaller shall be identified by a continuous white or gray colored insulation. Sizes larger than #6 AWG shall be identified by a distinctive white marking at its termination, marking shall encircle the insulation.
 - 2. Equipment grounding conductors sizes #6 AWG and smaller shall be insulated and individually identified with an outer finish that is green or green with one or more yellow stripes. Equipment grounding conductors larger than #6 AWG shall be insulated and individually identified at time of installation at each end and at every point where the conductor is accessible by encircling the exposed insulation with green tape.
- C. Multi conductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Type MC cable above accessible ceilings:

1. Not more than 6 feet length as final connection to a luminaire.
 2. May be spliced in overhead boxes, dropped into and routed concealed in walls to serve receptacles and other wall-mounted devices. May be routed horizontally, concealed in walls to serve other receptacles and wall-mounted devices.
- C. Type MC cables shall not be used as feeders, homerun branch circuits, or branch circuits between boxes above accessible ceilings. Cable shall not be routed exposed and/or surface mounted.
1. Type MC cable may be used as branch circuits below raised floors.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- F. Do not install cables exposed.
- G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least **12 inches (300 mm)** of slack.

3.4 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Firestopping."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.3 QUALITY ASSURANCE

- A. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches **(6.3 by 100 mm)** in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless -type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits including Type MC cable branch circuits.
- B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.3 INSTALLATION

- A. Equipment Grounding Conductors: Route within feeder and branch circuit conduits and within Type MC cable.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates if required.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Light Steel: Sheet metal screws.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions required or indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Nonmetal wireways and auxiliary gutters.
 - 5. Surface raceways.
 - 6. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Division 27 Section "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
 - 2. Division 28 Section "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
 - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 3. Anamet Electrical, Inc.
 - 4. Electri-Flex Company.
 - 5. O-Z/Gedney; a brand of EGS Electrical Group.
 - 6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
 - 7. Republic Conduit.
 - 8. Robroy Industries.
 - 9. Southwire Company.
 - 10. Thomas & Betts Corporation.
 - 11. Western Tube and Conduit Corporation.
 - 12. Wheatland Tube Company; a division of John Maneely Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Setscrew.
 - 2. Expansion/Deflection Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.

5. CertainTeed Corp.
 6. Condux International, Inc.
 7. Electri-Flex Company.
 8. Kraloy.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Niedax-Kleinhuis USA, Inc.
 11. RACO; a Hubbell company.
 12. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. LFNC: Comply with UL 1660.
- E. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cooper B-Line, Inc.
 2. Hoffman; a Pentair company.
 3. Mono-Systems, Inc.
 4. Square D; a brand of Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 Type 4Type 12 unless otherwise indicated, and sized according to NFPA 70.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Panduit Corp.
 - b. Wiremold / Legrand.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Panduit Corp.
 - b. Wiremold / Legrand.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Adalet.
 2. Cooper Technologies Company; Cooper Crouse-Hinds.
 3. EGS/Appleton Electric.
 4. Erickson Electrical Equipment Company.
 5. FSR Inc.
 6. Hoffman; a Pentair company.
 7. Hubbell Incorporated; Killark Division.
 8. Kraloy.
 9. Milbank Manufacturing Co.
 10. Mono-Systems, Inc.
 11. O-Z/Gedney; a brand of EGS Electrical Group.
 12. RACO; a Hubbell Company.
 13. Robroy Industries.
 14. Spring City Electrical Manufacturing Company.
 15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
 16. Thomas & Betts Corporation.
 17. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- I. Gangable boxes are allowed where specifically indicated.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Mechanical rooms.
 - c. Gymnasiums.
 - d. Riser conduits in shafts.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 5. Damp or Wet Locations: GRC.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 or 4X nonmetallic in institutional and commercial kitchens and damp or wet locations.
- B. Minimum Raceway Size: See General Drawing Notes.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.

- D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- I. Stub-ups to Above Recessed Ceilings:
 - 1. Use a conduit bushing to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts.
- L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- O. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- P. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Q. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- R. Expansion/Deflection-Joint Fittings:

1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 3. Install fitting(s) that provide expansion and contraction and deflection for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion/deflection fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion/deflection-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not indicated, give priority to ADA requirements. Install boxes with height measured as indicated on symbol legend.
- U. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- V. Locate boxes so that cover or plate will not span different building finishes.
- W. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Division 07 Section "Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED Submittals:
 - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
 - b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 2. Sealant shall have VOC content number in g/L in support of LEED objectives. Calculate according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

- b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
- 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- 3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
- 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of new walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level or as indicated.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

- 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
- 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Identification for equipment enclosures.
 - 2. Identification for conductors.
 - 3. Cable ties.

1.3 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.2 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.3 CABLE TIES

- A. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
 - 1. Minimum Width: 3/16 inch (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
 - 5. Color: Black.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for feeder and branch-circuit conductors.
 - a. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral: White.
 - b. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral: White or Gray.
 - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
 - 2. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with drawings and details. Apply labels to disconnect switches and protection equipment, control panels, . Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high

letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

- b. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
- b. Enclosures and electrical cabinets.
- c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- d. Power transfer equipment.

END OF SECTION 260553

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities as indicated:
 - 1. Distribution transformers.

1.3 ACTION SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each transformer type through same source and manufacturer as for panelboards and switchboards.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- E. Taps for Transformers 7.5 to 24 kVA: Manufacturer's standard.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- H. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 - 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 - 2. Tested according to NEMA TP 2.
- I. K-Factor Rating: Transformers serving MDF and IDF room loads shall be K-4 rated and shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-rating.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-4 rating.
 - 2. Indicate value of K-rating on transformer nameplate.
- J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Install suspended transformers via formed steel channel trapeze with threaded rod supports securely attached to the above structure.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower

than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner without written permission obtained at least 2 days in advance.

1.9 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 WARRANTY

- 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 3. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: As required.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Tin-plated aluminum.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Main and Neutral Lugs: Mechanical type.
 - 2. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 3. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 4. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Rating to equal or exceed that of panelboard to be replaced.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.

- C. Mains: Circuit breaker or Lugs only.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of cabinet 78 inches above finished floor unless otherwise indicated.
- C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- D. Install filler plates in unused spaces.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included . Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Weather-resistant receptacles.
 - 4. Snap switches and wall-box dimmers.
 - 5. Floor service outlets, poke-through assemblies.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), CR5362 (duplex).
 - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed-through or non-feed-through type as indicated by the circuiting.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.6 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - b. Two Pole:
 - 1) Cooper; AH1222.
 - 2) Hubbell; HBL1222.
 - 3) Leviton; 1222-2.
 - 4) Pass & Seymour; CSB20AC2.
 - c. Three Way:
 - 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Leviton; 1223-2.
 - 4) Pass & Seymour; CSB20AC3.
 - d. Four Way:
 - 1) Cooper; AH1224.
 - 2) Hubbell; HBL1224.
 - 3) Leviton; 1224-2.
 - 4) Pass & Seymour; CSB20AC4.
- C. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Cooper; AH1221L.
 - b. Hubbell; HBL1221L.

- c. Leviton; 1221-2L.
- d. Pass & Seymour; PS20AC1-L.

- 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.7 DECORATOR-STYLE DEVICES

- A. Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6252.
 - b. Hubbell; DR15.
 - c. Leviton; 16252.
 - d. Pass & Seymour; 26252.
- B. GFCI, Convenience Receptacles: Square face, 125 V, 15 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF15.
 - b. Hubbell; GF15LA.
 - c. Leviton; 8599.
 - d. Pass & Seymour; 1594.
- C. Toggle Switches, Square Face, 120/277 V, 15 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 7621 (single pole), 7623 (three way).
 - b. Hubbell; DS115 (single pole), DS315 (three way).
 - c. Leviton; 5621-2 (single pole), 5623-2 (three way).
 - d. Pass & Seymour; 2621 (single pole), 2623 (three way).

2.8 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Wall plate material, finish and color to be selected by the Architect.
 - 3. Material for Finished Spaces: Smooth, high-impact thermoplastic.
 - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations with cord and plug inserted and closed cover.
- B. Wet-Location, Weatherproof Cover : NEMA 250, complying with Type 3R, weather-resistant thermoplastic, with cord and plug inserted and closed, lockable cover.

2.9 FLOOR SERVICE FITTINGS

- A. Type: Modular, dual-service units suitable for wiring method used. See drawings for specific product manufacturer and type.

2.10 POKE-THROUGH ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Wiremold/Legrand.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

2.11 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color or as selected by the Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- B. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

C. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

D. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on inside of face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches .

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 3. Current-limitation curves for fuses with current-limiting characteristics.
 - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 5. Coordination charts and tables and related data.
 - 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, :
 - 1. Cooper Bussmann, Inc.
 - 2. Edison Fuse, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Littelfuse, Inc.
 - 5. .

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Motor Branch Circuits: Class RK5, time delay.
- B. Other branch circuits: Class RK1, time delay

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. .
- B. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- C. Manufacturer's field service report.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.
 - 3. .

1.8 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
 - 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 4. Lugs: mechanical type, suitable for number, size, and conductor material.
 - 5. .

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

- F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- H. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 MOLDED-CASE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 - 3. Retain subparagraph below if retaining options requiring integral or remote-control power in subparagraphs above and if control power for remote indication or operation is not specified in other Sections. See "Control Power Options" Article in the Evaluations for various sources available for control power. Although other voltages are available, the Section Text includes only those that are most frequently encountered and listed in manufacturers' literature. First option below may not be available in all voltages; coordinate with manufacturers' literature.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1

2. Outdoor Locations: NEMA 250, Type 3R
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Retain paragraph below if tests and inspections are performed by Contractor or manufacturer's field-service representative engaged by Contractor.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 264313 – SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment. Manufacturer's written instructions shall be followed for SPD location, maximum lead length and accessibility.
- B. Contractor may provide SPDs integrally mounted within the distribution apparatus protected if electrical room dimensions will not accommodate field-mounted SPDs.
- C. Related Sections:
 - 1. Division 26 Section "Panelboards."

1.3 DEFINITIONS

- A. SPD: Surge Protection Device.
- B. SVR: Suppression voltage rating (clamping voltage).
- C. TVSS: Transient voltage surge suppressor(s), both singular and plural; also, transient voltage surge suppression.
- D. VPR: Voltage Protection Rating (6kV/3kA, 8 by 20 micro-sec waveform).
- E. SPD = TVSS.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- B. Comply with UL 1449, Third Edition.
- C. Comply with UL 1283, Fifth Edition.
- D. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 2,000 feet (6090 m) above sea level.

1.8 COORDINATION

- A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of device acceptance by the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. Current Technology Inc.; Danaher Power Solutions.
 - 3. Danaher Power Solutions; United Power Products.
 - 4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 6. LEA International.

7. Leviton Mfg. Company Inc.
8. Northern Technologies, Inc.; a division of Emerson Network Power.
9. Siemens Energy & Automation, Inc.
10. Square D; a brand of Schneider Electric.
11. Surge Suppression Incorporated.
12. Thor Systems, Inc.

2.2 PANELBOARD SUPPRESSORS

A. Surge Protection Devices:

1. Comply with UL 1449, 3rd Edition and UL 1283 5th Edition.
2. Non-modular.
3. 100 kA interrupting capacity.
4. LED indicator lights for power and protection status.
5. Audible alarm, with silencing switch, to indicate when protection has failed.

B. Surge Specifications:

1. Peak Single-Impulse Surge Current Rating: 50 kA per mode.
2. Seven (7) mode: L-N, L-G, N-G.
3. MCOV:
 - a. 480V system-550V.
 - b. 208V system-320V.
4. SPD Type: 2

C. VPR tested with 3000A, 8-by-20-mic.sec impulse.

1. 480/277 V grounded wye:
 - a. Line to Neutral: 1200
 - b. Line to Ground: 1200
 - c. Neutral to Ground: 900
 - d. Line to Line: 1800
2. 208/120 V grounded wye:
 - a. Line to Neutral: 700
 - b. Line to Ground: 700
 - c. Neutral to Ground: 800
 - d. Line to Line: 1000

D. SVR tested with 500A, 8-by-20-mic.sec impulse.

1. 480/277 V grounded wye:
 - a. Line to Neutral: 869
 - b. Line to Ground: 853
 - c. Neutral to Ground: 520
 - d. Line to Line: 1627

2. 208/120 V grounded wye:
 - a. Line to Neutral: 403
 - b. Line to Ground: 405
 - c. Neutral to Ground: 440
 - d. Line to Line: 736

2.3 ENCLOSURES

- A. Indoor Enclosures: Polycarbonate with clear hinged lid and NEMA 4X polycarbonate or NEMA 1 steel enclosure with piano hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 1. Provide 30A circuit breaker as a dedicated disconnecting means for SPD serving panelboards.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
 2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
 3. Complete startup checks according to manufacturer's written instructions.
- C. SPD device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Do not energize or connect service entrance equipment, panel boards, control terminals, and data terminals to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 26 43 13

SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Ballast, including BF.
 - 3. Energy-efficiency data.
 - 4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Installation instructions.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- F. Diffusers and Globes:
 - 1. Acrylic Lighting Diffusers: See Lighting Fixture Schedule.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
 - 1. Instant Start or Programmed Start.
 - 2. Designed for type and quantity of lamps served.
 - 3. Operate from 50/60 Hz, 120V or 277V source with sustained variations of $\pm 10\%$.
 - 4. Provide lamp end-of-life (EOL) protection circuit.
 - 5. Sound Rating: Class A.
 - 6. Input current Total Harmonic Distortion Rating: Less than 10 percent.
 - 7. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - 8. Operating Frequency: 42 kHz or higher.
 - 9. Lamp Current Crest Factor: 1.7 or less.
 - 10. BF: 0.85 or higher.
 - 11. Power Factor: 0.98 or higher.
 - 12. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.
- C. Electronic Programmed-Start Ballasts for T8, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
 - 1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
 - 2. Automatic lamp starting after lamp replacement.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:
1. Lamp end-of-life detection and shutdown circuit.
 2. Automatic lamp starting after lamp replacement.
 3. Sound Rating: Class A.
 4. Total Harmonic Distortion Rating: Less than 10 percent.
 5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 6. Operating Frequency: 65 kHz or higher.
 7. Lamp Current Crest Factor: 1.7 or less.
 8. BF: 1.0 or higher unless otherwise indicated.
 9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2.6 FLUORESCENT LAMPS

- A. Lamps shall be as indicated on the drawings with average rated life of 20,000 hours unless otherwise indicated.

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).
- E. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system wires independent of the ceiling suspension devices for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- E. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide one visit to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 270000 - COMMUNICATIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 01 General Requirements shall be considered a part of this section and shall have the same force as if printed herein full.

1.2 QUALITY ASSURANCE

- A. Specifications, Standards and Codes
 - B. All work shall be in accordance with the following:
 - 1. The 2002 edition of the National Electrical Code (NFPA 70).
 - 2. The 1999 edition of the Standard Building Code.
 - 3. The 1998 edition of the Life Safety Code (NFPA 101).
 - 4. The National Electrical Safety Code (ANSI C-2).
 - 5. National Electrical Manufacturers Association (NEMA)
 - 6. Telecommunications Industries Association (TIA)
 - 7. Electronic Industries Association (EIA)
 - 8. National Electrical Safety Code (NESC)
 - 9. Institute of Electrical & Electronics Engineers (IEEE)
 - 10. Underwriters Laboratories (UL)
 - 11. American Standards Association (ASA)
 - 12. Federal Communications Commission (FCC)
 - 13. Occupational Safety and Health Administration (OSHA)
 - 14. American Society of Testing Material (ASTM)
 - 15. Americans with Disabilities Act (ADA)
 - 16. Local city and county ordinances governing electrical work.
- *In the event of conflicts, the more stringent provisions shall apply.

1.3 SCOPE

- A. The work to be done under this Section of the Specifications shall include the furnishing of labor, material, equipment and tools required for the complete installation of the work indicated on the Drawings or as specified herein.
- B. All materials, obviously a part of the Telecommunications Infrastructures and necessary to its proper operation, but not specifically mentioned or shown on the Drawings, shall be furnished and installed without additional charge.
- C. The Drawings and Specifications are complementary to each other and what is called for by one shall be as binding as if called for by both. If a discrepancy exists between the Drawing and Specifications, the higher cost shall be included, and the engineer shall be notified of the discrepancy.

1.4 WORK INCLUDED

- A. The Communications Infrastructures installed and work performed under this Division of the Specifications shall include but not necessarily be limited to the following:
- B. Voice/Data Cabling Infrastructure

- C. Telecommunications conduits, raceways, cable tray, racks, cabinets and equipment mounting boards as indicated on the Drawings.
- D. Grounding and Bonding

1.5 DEFINITIONS

- A. Terms: The following definitions of terms supplement those of the GENERAL REQUIREMENTS and are applicable to DIVISION 27 - COMMUNICATIONS.
 - 1. Provide: As used herein shall mean "furnish, install and test (if applicable) complete".
 - 2. Infrastructure: As used herein shall mean cable, installed in conduit, raceway, cable tray or j-hooks with all required boxes, fittings, connectors, and accessories; completely installed."
 - 3. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

1.6 DRAWINGS

- A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures and equipment. The Contractor shall carefully investigate the structural and finish conditions affecting his work and arrange his work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, the Contractor shall so advise the Engineer and secure approval before proceeding with such work.
- B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, the Contractor shall request shop Drawings, equipment location Drawings, foundation Drawings, and any other data required by him to locate the concealed conduit before the floor slab is poured.
- C. Materials, equipment or labor not indicated but which can be reasonably inferred to be necessary for a complete installation shall be provided. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.
- D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.
- E. The Contractor shall not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Engineer.
- F. The location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings.
- G. Schematic diagrams shown on the Drawings indicate the required functions only. The technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Additional labor and materials required for such deviations shall be furnished at the Contractor's expense.
- H. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Provide compatible products for each ceiling type
- I. Review all Drawings for modular furniture.
- J. Portions of these Drawings and Specifications are abbreviated and may include incomplete sentences. Omissions of words or phrases such as "the Contractor shall", "shall be", "as indicated on the Drawings", "In accordance with", "a", "the" and "all are intended" shall be supplied by inference.

1.7 SUBMITTALS

February 7, 2014

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- A. Submit for approval, details of all materials, equipment and systems to be furnished. Work shall not proceed without the Owner and/or the Project Manager's approval of the submitted items. Three (3) copies of the following shall be submitted:
 - 1. Submittals for individual systems and equipment assemblies that consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.
 - 2. Contractor shall generate shop Drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop Drawings with record Drawings on hard copy. Shop Drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction Drawings.
- B. Any materials and equipment listed that are not in accordance with specification requirements may be rejected.
- C. The approval of material, equipment, systems and shop Drawings is a general approval subject to the contract Drawings, Specifications and verification of all measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. The Contractor shall carefully check and correct all shop Drawings prior to submission for approval.
- D. Submittals for each section shall vary.

1.8 QUALITY ASSURANCE

- A. Equipment and materials required for installation under these Specifications shall be the current model and new (less than one [1] year from the date of manufacture), unused and without blemish or defect.
- B. Equipment shall bear labels attesting to Underwriters Laboratories or certification by other recognized laboratory, where subject to label service. Manufacturers of equipment and materials pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three (3) years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.9 CONTRACTOR QUALIFICATIONS

- A. The Telecommunications Contractor must be certified to extend a NetClear **25-year** Static, Dynamic and Applications Warranty. All contractors must be an approved Ortronics Certified Installer at a Plus tier (CIP, CIP-GOLD, CIP-PLATINUM,) and/or Berk-Tek Certified OASIS Integrator. A copy of certification documents must be submitted with the quote in order for such quote to be valid. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the Ortronics CI/CIP Program and Berk-Tek OASIS Program. At least 30 percent of the copper installation and termination crew must be certified by BICSI, Berk-Tek, or Ortronics with a Technicians Level of Training.
- B. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. The Contractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.
- C. Telecommunications Systems specified shall be installed under the direction of a qualified Contractor. Qualification requirements shall include submittal by the Contractor to the Architect of the following:
 - 1. List of previous projects of this scope, size and nature, including names and sizes of projects, description of work, times of completion and names of contact persons for

- reference.
2. Contractor shall be certified by Berk-Tek/ Ortronics to provide warranty for the cabling system.
 3. Contractor shall provide documentation of certification.
 4. Contractor shall be licensed by the State of Georgia as a low voltage contractor.

1.10 COORDINATION WITH OTHER TRADES

- A. The Contractor shall coordinate telecommunications work with that of other Sections as required to ensure that the entire telecommunications work will be carried out in an orderly, complete and coordinated fashion.

1.11 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition before the completion of this project.

1.12 PERMITS

- A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.13 RENOVATIONS AND ADDITIONS

- A. All work that would adversely affect the normal operation of the other portions of the Owner's property shall be done at a time other than normal working hours.
- B. Prior to submitting bids on the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project.
- C. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems shall be restored to their original and operating condition. Remove all equipment indicated to be demolished, including outlets, devices, raceways and support structures.
- D. Care shall be exercised in the removal and storage of equipment indicated to be relocated or removed and reused. Prior to placing back into service, equipment shall be cleaned, and marred or chipped paint surfaces touched-up.
- E. Provide all coring, cutting and patching to existing walls, floors, etc., required for the removal of existing work or the installation of new work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials used in this work shall be new and shall bear the inspection label of Underwriters' Laboratories Inc. or certification by other recognized laboratory.
- B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard

Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM), are made a part of these Specifications and shall apply wherever applicable.

- C. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- D. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer or partner manufacturers that offer a certified solution.
- E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.
- F. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
- G. Components shall be compatible with each other and with the total assembly for the intended service.

PART 3 - EXECUTION

3.1 EXAMINATION OF SURFACE CONDITIONS

- A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.
- B. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
- C. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.2 PROTECTION OF SYSTEMS AND EQUIPMENT

- A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
- B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.
- C. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.
- D. As determined by the Architect, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Project Manager shall be final.
- E. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.3 ACCESS TO EQUIPMENT

- A. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.

- B. Working spaces shall be not less than specified in the National Electrical Code (NEC) for voltages specified.
- C. Where the Architect determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

3.4 CLEANING

- A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.
- B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

3.5 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.
- B. Results Expected: Systems shall be complete and operational and controls shall be set and calibrated. Testing, start-up and cleaning work shall be complete.
- C. Maintenance Materials: Special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered to the Owner.

3.06 TESTING AND VERIFICATION

- A. See specific Division 27 sections for testing parameters of sub-systems.
- B. The Contractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
- C. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.
- D. The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the telecommunications systems, components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test". Even though no formal environmental testing is required, the Contractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test".
- E. The Contractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The Contractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.
- F. The Contractor shall satisfy all items detailed in the final acceptance check-off list (punch list). The list shall be a complete representation of specified installation requirements. At the time of final

acceptance punch list items shall be corrected until the system is found to be acceptable to the Owner and the Project Manager.

- G. After the Contractor systems have been installed and tested, the completed test plan shall be signed by the Telecommunications Contractor Project Manager and submitted for approval.

END OF SECTION

SECTION 270510 – FIRE STOPPING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the products and execution requirements relating to Firestopping for Communications Systems.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. Typical firestopping installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.
- D. Provide a complete and operational system as specified here-in.

1.02 SUBMITTALS

- A. Product data: Manufacturer's specifications and technical data including the following:
 - 1 Detailed specification of construction and fabrication.
 - 2. Manufacturer's installation instructions.

1.03 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install all Firestopping Materials.

PART 2 - PRODUCTS

2.01 APPROVED PRODUCTS

- A. Approved Firestopping manufacturer(s):
 - 1. Flamestopper Thru-Wall Fitting - Wiremold Company (Firestop Devices)
 - 2. Unique Firestop Products (Firestop Devices)
 - 3. STI Firestop Products (Firestop Devices, Putties, Caulks, Sealants, etc.)
 - 4. Hilti (Putties, Caulks, Sealants, etc.)

2.02 TYPES OF PRODUCTS

- A. Sealants
 - 1. Intumescent Firestop Sealants and Caulks
 - 2. Latex Firestop Sealant
 - 3. Acrylic Water-Based Sealant
 - 4. Silicone Firestop Sealants and Caulks
 - 5. Firestop Putty

6. Firestop Collars
 7. Wrap Strips
 8. 2-Part Silicone Firestop Foam
 9. Firestop Mortar
 10. Firestop Pillows
 11. Elastomeric Spray
 12. Accessories: Forming/Damming Materials: Mineral fiberboard or other type as per manufacturer recommendation.
- B. Firestop Devices
1. Thru-Wall Fitting (Flamestopper by Wiremold)
 - a. The firestop device box shall be constructed of 16 gage G90 steel.
 - b. The firestop device intumescent block shall be constructed of a graphite base material with expansion starting at 375°F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
 - c. The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with No. 10-32 screws use to adjust opening size.
 - d. The firestop device shall be available for 2" and 4" trade size EMT conduit.
 - e. The firestop device shall be available in safety yellow powder coat, custom colors and an unpainted galvanized finish.
 2. Threaded Firestop Device (Unique Firestop Products)
 - a. Threaded steel sleeve device incorporating flat washers secured by threaded device shall be installed around cables. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
 3. Smooth Firestop Device (Unique Firestop Products)
 - a. Smooth steel sleeve device incorporating flat washers secured by sliding compression couplers. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
 4. Split-Sleeve Firestop Device (Unique Firestop Products)
 - a. Threaded steel sleeve halves incorporating split couplings and slotted washers to fit the specific diameter of the opening. The device shall be available in 1, 2 and 4-inch sizes. Maximum diameter of the wall penetration for 1, 2 and 4-inch sizes shall be 1-1/4, 2-7/16 and 4-1/2 inches respectively.
 5. Fire Rated Cable Pathway (STI EZ-PATH)
 - a. Fire rated cable pathway device modules shall be comprised of steel raceway with intumescent foam pads allowing 0-100 percent cable fill.

2.03 UL CLASSIFICATION

- A. Thru-Wall Fitting - The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark.
- B. Threaded, Smooth and Split-Sleeve Firestop Devices - Firestopping sealants and devices shall be used together as a firestop system. All firestop systems shall bear a UL Classification system number. UL Classification system numbers are as follows:
1. Threaded Firestop System
 - a. Block Wall - W-J-3049
 - b. Dry Wall - W-L-3138
 2. Threaded Firestop System (Vertical)
 - a. Slab - F-A-3010
 3. Smooth Firestop System

- a. Block Wall - W-J-3048
- b. Dry Wall - W-L-3137
- 4. Split-Sleeve Firestop System
 - a. Block Wall - W-J-3047
 - b. Dry Wall - W-L-3136

2.04 FIRESTOPPING SYSTEMS

- A. Thru-Wall Fitting Firestop System:
 - 1. The device shall be classified for use in one-, two-, three, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of six cfm. The devices shall also been tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- B. Threaded, Smooth and Split-Sleeve Firestop Systems:
 - 1. Shall conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
 - 2. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating when required by code authority shall be based on measurement of the temperature rise on penetrating item(s). The fire test shall be conducted with a minimum positive pressure differential of 0.01 inches of water column.
 - 3. For joints, must be tested to UL 2079 with movement capabilities equal to those of the anticipated conditions.
- C. Firestopping materials and systems must be capable of closing or filling through-openings created by 1) the burning or melting of combustible pipes, cable jacketing, or pipe insulation materials, or 2) deflection of sheet metal due to thermal expansion (electrical & mechanical duct work).
- D. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.
- E. Firestopping sealants must be flexible, allowing for normal pipe movement.
- F. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
- G. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.

PART 3 - EXECUTION

3.01 CONDITIONS REQUIRING FIRESTOPPING

- A. General:
 - 1. Provide firestopping for conditions specified whether or not firestopping is indicated, and if indicated, whether such material is designed as insulation, safing, or otherwise.
- B. Through-Penetrations:
 - 1. Firestopping shall be installed in all open penetrations and in the annular space in all penetrations in any bearing or non-bearing fire-rated barrier.
- C. Membrane-Penetrations:
 - 1. Where required by code, all membrane-penetrations in rated walls shall be protected with firestopping products that meet the requirements of third party time/temperature testing.
- D. Construction Joints/Gaps:
 - 1. Firestopping shall be provided between the edges of floor slabs and exterior walls, between the tops of walls and the underside of floors, in the control joint in masonry walls and floors and in expansion joints.

- E. Smoke-Stopping:
 - 1. As required by the other Sections, Smoke-Stops shall be provided for Through-Penetrations, Membrane-Penetrations, and Construction Gaps with a material approved and tested for such application.

3.02 EXAMINATION

- A. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Verify that environmental conditions are safe and suitable for installation of firestop products.
- C. Verify that all pipes, conduit, cable, and other items that penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.03 INSTALLATION

- A. General:
 - 1. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's detailed installation procedures.
 - 2. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
 - 3. Unless specified and approved, all insulation used in conjunction with through-penetrants shall remain intact and undamaged and may not be removed.
 - 4. Seal holes and penetrations to ensure an effective smoke seal.
 - 5. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
 - 6. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
 - 7. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.
- B. Dam Construction:
 - 1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.

3.04 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instructions and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping that are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification.

3.05 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surfaces.
- B. Leave finished work in a neat and clean condition with no evidence of spill overs or damage to adjacent surfaces.

3.06 IDENTIFICATION

- A. Refer to section 27 05 53 for labeling details.

END OF SECTION

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section.
- C. This specification describes the products and execution requirements relating to Pathways for Communications Systems.

1.2 SUBMITTALS

- A. Provide product data.

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install complete Conduit System.
 - 2. Furnish and install all Telecommunications Outlet Boxes.
 - 3. Furnish and install all Pull Boxes.
 - 4. Furnish and install complete Cable Tray System.
 - 5. Furnish and install all Cable Hangers.
 - 6. Furnish and install all Velcro Straps.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Rigid/Intermediate Conduit manufacturer(s)
 - 1. Allied
 - 2. Triangle
 - 3. Wheatland
 - 4. Youngstown
- B. Non-Metallic (PVC) manufacturer(s):
 - 1. Carlon
 - 2. Georgia Pipe Company
 - 3. Or Approved Equal
- C. Electrical Metallic Tubing (EMT) manufacturer(s):
 - 1. Allied
 - 2. Triangle
 - 3. Wheatland
 - 4. Youngstown

- D. EMT Fittings manufacturer(s):
 - 1. Thomas & Betts
 - 2. Steel City
 - 3. Or Approved Equal
- G. Innerduct manufacturer(s):
 - 1. Endot Industries Part Numbers 2" non-plenum – 1050
 - 2. 1-1/4" non-plenum – 1250
 - 3. 1" non-plenum – 2000
 - 4. 1-1/4 plenum – PL/1250
- H. Metallic Telecommunications Outlet Box manufacturer(s):
 - 1. Steel City
 - 2. Raco
 - 3. Or Approved Equal
- J. Pull Box manufacturer(s):
 - 1. Hoffman
 - 2. Or Approved Equal
- K. Approved Cable Tray System manufacturer(s):
 - 1. Flex Tray
 - 2. Wiremold
 - 3. EZ Tray
 - 4. B-Line
- L. Approved Cable Hanger manufacturer(s):
 - 1. Erico Products – Caddy Part Numbers: J-Hook/Sling CABLECAT
 - 2. Bridle Ring 4BRT-20
 - 3. Bridle Ring Bracket 4-TIB
- M. Approved Velcro Strap manufacturer(s):
 - 1. Panduit
 - 2. Or Approved Equal

2.2 CONDUIT

- A. Rigid and Intermediate Conduit
 - 1. Rigid conduit, intermediate conduit, couplings, locknuts, bushings, elbows and connectors shall be standard thread. All materials shall be steel. Set screw or non-threaded fittings are not permitted.
- B. Non-Metallic (PVC) Conduit
 - 1. Non-metallic conduit shall be heavy wall, Schedule 40 PVC.
 - 2. Couplings and connectors for non-metallic conduit shall be of the same material and be the product of the same manufacturer of the conduit furnished.
- C. Electrical Metallic Tubing (EMT)
 - 1. Electrical metallic tubing (EMT), couplings and connectors shall be steel. Malleable iron, pressure-cast or die-cast fittings are not permitted.
 - 2. Fittings for 2" EMT and smaller shall be steel set screw type, except where otherwise noted. Fittings for 2.5" and larger shall be steel set screw type with two (2) screws for connectors and four (4) screws for couplings. All connectors shall be insulated throat type.
- D. Conduit Support
 - 1. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose and sized appropriately for the conduit type and diameter. Support individual

- conduits 1-1/2 inch and smaller with 1/4 inch threaded steel rods and use 3/8 inch rods for 2 inch and larger.
 - 2. Conduit support channels shall be 14 gauge galvanized (or equivalent treatment) channel sized for the amount of conduit to be supported. Channel suspension shall be 3/8" threaded steel rods. Attach suspension rods to structure with swivel type connectors. Conduit straps shall be spring steel type compatible with channel.
 - 3. Conduit straps shall be single hole cast metal type or two hole galvanized metal type. Conduit clamps shall be spring steel type for use with exposed structural steel.
- E. Innerduct
- 1. Exposed innerduct shall be rated CMP (plenum), corrugated plastic equipped with pull-string or mule tape.
 - 2. Sizes shall be 2", 1-1/4" & 1" inside diameter.
 - 3. See Drawings for innerduct details.

2.3 METALLIC TELECOMMUNICATIONS OUTLET BOXES

- A. Metallic outlet boxes and device covers shall be galvanized steel not less than 1/16" thick.
- B. The dimensions of the metallic outlet box shall be 4" x 4" square with a minimum depth of 2-1/8".
- C. Metallic outlet boxes shall be equipped with single device covers (or two-device covers where needed). Where installed in plaster, gypsum board, etc., covers shall be raised to compensate for the thickness of the wall finish.
- D. Where metallic outlet boxes are to be empty for future use, blank coverplates shall be used.

2.5 PULL BOXES

- A. Pull boxes shall be constructed of galvanized steel with flat, removable covers fastened with plated steel screws.
- B. Pull boxes shall be equipped with keyhole screw slots in the cover to permit removal of the cover without extracting the screws.
- C. Pull boxes shall have provisions for grounding.

2.7 CABLE HANGERS

- A. J-Hooks
 - 1. J-hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables. J-hook shall be cULus Listed.
 - 2. J-hooks shall have flared edges to prevent damage while installing cables.
 - 3. J-hooks sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
- B. Adjustable Non-Continuous Cable Support Sling
 - 1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425, 4-pair, balanced twisted pair; rated for indoor use in non-corrosive environments. Rated to support Category 5e and higher cable, or optical fiber cable. Cable support sling shall be cULus Listed.
 - 2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 - 3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
- C. Bridle Rings

1. Bridle rings shall be made of steel, rated for indoor use in non-corrosive environments.
2. Bridle rings shall be UL listed.
3. Shall have an ultimate static load limit of 50 lbs. depending on application, select threaded, unthreaded or wood screw variety.

2.8 VELCRO STRAPS

- A. Velcro Straps
 1. Cables shall be fastened to support structures with Velcro straps.
 2. Velcro straps installed in air handling spaces must be plenum rated.
 - a. Plenum Velcro strap color shall be red.

PART 3 - EXECUTION

3.1 PENETRATIONS

- A. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base of building. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Project Manager as required by limited working space. X-ray all floor penetrations accordingly.
- B. Holes shall be located so as not to affect structural sections such as ribs or beams.
- C. Holes shall be laid out in advance. The Project Manager shall be advised prior to drilling through structural sections, for determination of proper layout.
- D. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors provide a code compliant effective barrier against the spread of fire, smoke and gases.
- E. All penetrations where continuous conduit is not used shall be sleeved with a section of EMT conduit of appropriate diameter to accommodate all cable and firestopping materials, and shall extend at least one inch beyond both sides of the penetration.
- F. No gaps or rough edges shall be allowed between wall and conduit/sleeve.

3.2 CONDUIT SYSTEM

- A. Conceal all conduits, except in unfinished spaces such as equipment rooms or as indicated by symbol on the Drawings.
- B. Leave all empty conduits with a 200 pound test nylon cord pull line.
- C. Flattened, dented, or deformed conduits are not permitted and shall be removed and replaced.
- D. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on steel.
- E. Install conduit with wiring, including homeruns as indicated on the Drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.
- F. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
- G. Attach backbone conduits larger than one-inch trade diameter to or from structure on intervals not exceeding twelve feet with conduit beam clamps, one-hole conduit straps or trapeze type support.
- H. Where conduits must pass through structural members obtain approval of Architect.
- I. Install all conduits or sleeves penetrating or routed within rated firewalls or fire floors to maintain

- fire rating of wall or floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
- J. Provide expansion and deflection coupling where conduit passes over a building expansion joint.
- K. All other conduit, unless specified herein, shall be electrical metallic tubing (EMT). PVC conduit is not allowed in exposed or concealed areas, but only within concrete.
- L. Conduit Installations Within Slab/Floor
1. Conduit shall be run following the most direct route between points.
 2. Conduit shall not be installed in concrete where the outside diameter is larger than 1/3 of the slab thickness.
 3. Conduits shall not be installed within shear walls unless specifically indicated on the Drawings. Conduit shall not be run directly below and parallel with load bearing walls.
 4. Protect each metallic conduit installed in concrete slab or conduits 1-1/2 inch and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
 5. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.
 6. Provide expansion fittings in all conduits where length or run exceeds 200 feet or where conduits pass through building expansion joints.
 7. Install all conduits penetrating or routed within rated fire floors to maintain the fire rating of the floor. Conduit shall not be installed in rated floors or walls if it compromises or violates the fire rating of floor or wall. Refer to architectural documents.
 8. Conduits installed within concrete floor slabs which are in direct contact with grade or which penetrate the building roof shall be galvanized rigid steel (G.R.S.), intermediate metal conduit (I.M.C.) or Schedule 40, heavy wall PVC.
- M. Telecommunications cables shall not occupy conduits with power cables.
- N. Metallic conduits shall be grounded in accordance with J-STD-607-A.
- O. For runs that total more than 100 feet in length, insert pull boxes so that no segment between boxes exceeds the 100 feet limit, except when floor duct is being used.
- P. Conduit runs shall not have more than two (2) 90-degree bends between pull points.
- Q. Telecommunications conduit system shall contain no condulets (also known as an LB).
- R. Horizontal Conduits
1. Support horizontal conduits at intervals not exceeding ten feet and within three feet of each outlet, junction box, backboard, enclosure or cabinet. Support conduits from structural steel members with spring steel type or beam conduit clamps and to non-metallic structural members with one-hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hanger rod and conduit clamp assembly, and multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.
 2. Each horizontal home-run conduit can serve from one (1) to three (3) outlet boxes. For one (1) outlet box, a 3/4" conduit shall be used, minimum. For two (2) outlet boxes, a 1" conduit shall be used, minimum. For three (3) outlet boxes, a 1-1/4" conduit shall be used, minimum.

3.3 TELECOMMUNICATIONS OUTLET BOXES

- A. Exact locations of the outlet boxes shall be coordinated with the electrical contractor and other trades.

- B. The approximate locations of the outlets are indicated on the Drawings. The exact locations shall be determined at the building. The right is reserved to change, without additional cost, the exact location of any outlet, a maximum of 10' before it is permanently installed.
- C. Orientation of outlet boxes (horizontal or vertical) shall be as indicated on the architectural elevations.
- D. Install all outlet boxes in finished areas flush with the wall. Maintain 1/4" or less space between outlet box front and finished wall surface.
- E. Outlet boxes shall be firmly anchored in place and shall not depend on the coverplate to hold it secure to the wall.
- F. Outlet boxes installed back-to-back in fire-rated walls shall be separated horizontally by a minimum of 24".

3.4 PULL BOXES

- A. Pull boxes shall be secured, independent of the conduit entries into the box. Pull boxes shall be secured to the building structure. In ceiling applications, pull boxes shall not be supported with ceiling wires.
- B. Conduits entering pull boxes shall connect to pull boxes using die-cast zinc connectors.
- C. Pull boxes shall be free from burrs, dirt and debris.
- D. Pull boxes shall be installed in accordance with ANSI/TIA/EIA-569-A.
- E. Pull boxes shall be grounded in accordance with J-STD-607-A.

3.5 CABLE TRAY SYSTEM

- A. Install trays in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of the NEC.
- B. All open trays shall be installed a minimum of six (6) inches away from any light fixture.
- C. Provide external grounding strap at expansion joints, sleeves, crossover and other locations where tray continuity is interrupted.
- D. Support all pathways from building construction. Do not support pathways from ductwork, piping or equipment hangers.
- E. Install cable tray level and straight.
- F. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete cable tray system.
- G. Cable trays shall not be used to house both low voltage and power cables unless cables are separated by a grounded physical barrier.
- H. Cable tray system shall be grounded in accordance with J-STD-607-A.

3.6 CABLE HANGERS

- A. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- B. Install cables using techniques, practices, and methods that are consistent with Category 6 or higher requirements and that supports Category 6 or higher performance of completed and linked

signal paths, end to end.

- C. Install cables without damaging conductors, shield, or jacket.
- D. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- E. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
- F. Do not exceed load ratings specified by manufacturer.
- G. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- H. To avoid electromagnetic interference (EMI), pathways shall provide minimum clearances of four feet from motors or transformers, one foot from conduit and cables used for electrical power distribution, and five inches from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical power cables or conduits.
- I. Bridle rings shall be installed in ceiling spaces where cables cannot be supported by j-hooks.

3.7 VELCRO STRAPS

- A. Velcro straps shall be installed around cables at intervals of 12" minimum.
- B. Do not over-cinch cables.

3.8 SYSTEM FURNITURE FEEDS

- A. Provide all system furniture feeds in accordance with construction Drawings.
- B. Wall system furniture data/voice feeds
 - 1. Data/voice system furniture feeds shall be installed next to the power feeds where possible, but shall be kept separate in the furniture raceway.
 - 2. The wall feed shall consist of a double gang steel backbox in the wall. Two 1.5" conduits shall be routed from the double gang box inside the wall and stubbed up above the ceiling. The box shall be located at the same height as the power feed box, or centered at 6" A.F.F.
 - 3. The backbox shall have a double-gang stainless steel cover plate with a 2" opening on the center to allow the cabling to exit the wall.
 - 4. All cabling exiting the cover plate shall be routed inside a plastic or rubber whip, which must be no longer than 4 feet (i.e. the furniture feed must not be located more than 4 feet from the system furniture cable entrance).
 - 5. The whip must be permanently attached to the wall cover plate, and no gap between the cover plate and the whip shall be visible from the outside. Similarly, the whip should go into the system furniture raceway without any visible gaps between the whip and the furniture, and it shall be permanently attached to the raceway.
 - 6. No more than 10 Category 6 cables shall be routed via a system furniture feed. Use additional system furniture feeds for additional cable capacity.
 - 7. If the contractor installing the furniture feed system will not install the data/voice cabling at the same time, pull strings must be provided from the conduit in the ceiling in the backbox, whip, and to the system furniture outlet openings, as to allow easy installation of the cabling by the installers. If the Drawings do not indicate any data/voice outlets to be installed in the furniture, the contractor shall prepare at least two outlets in the furniture for future use (i.e. route the pull-strings, and leave two knockouts in the raceway free for use).

8. Contractor shall ensure that the cabling path from the ceiling to the conduits, backbox, whip, and furniture at all times maintains a 1" bend radius in accordance with TIA/EIA standards for Category 6 cables.

3.9 IDENTIFICATION

- A. Refer to section 27 05 53 for labeling details.

END OF SECTION

SECTION 27-05-53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- C. This document describes the equipment and execution requirements relating to Identification for Communications Systems.
- D. Equipment specifications, general considerations, and guidelines are provided in this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.

1.02 SUBMITTALS

- A. Provide the following submittals:
 - 1. Product data
 - 2. Product samples
 - 3. Label sample showing example and text size for each item
 - 4. Software program sample

1.03 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Perform all Labeling.

PART 2 - PRODUCTS

2.01 LABELS

- A. All labels shall be vinyl.
- B. All labels shall have an adhesive backing for permanent attachment.
- C. All labels shall be of sufficient size. Minimum sizes shall be as follows:
 - 1. 1-1/2"W x 3/16"H for:
 - a. Outlets
 - b. Outlet cables
 - c. Patch panels
 - d. Ground wires
 - e. Backbone cable pairs
 - 2. 4"W x 1"H for:
 - a. Backbone cables
 - b. Equipment racks
 - c. MDF frames

- d. Active hardware and multiplexers

2.02 LABEL HOLDERS

- A. Labels attached to backbone cable bundles shall be installed on a label holder of sufficient size. Label holder to be plastic and have tie wrapping provisions.

2.03 SOFTWARE PROGRAM

- A. Software program shall be of the following types or similar:
 - 1. PANDUIT labeling program
 - 2. Brady labeling program
 - 3. Thomas & Betts labeling program
 - 4. Excel, customized

2.04 TEMPORARY LABELS

- A. Vinyl labels, hand written, with permanent marker.

2.05 CHARTS

- A. Provide printed charts containing required punch down and cross-connect information. Charts to be computer generated. File information shall be turned over to owner in printed and electronic format four (4) weeks prior to job completion.

2.06 AS-BUILT PLAN

- A. Description: At the completion of the project, provide an "as-built" floor plan of each floor to the owner.

PART 3 – EXECUTION

3.01 LABELING REQUIREMENTS

- A. Labeling shall be done in accordance with the recommendations made in the ANSI/TIA/EIA-606 document, manufacturer's recommendations and best industry practices.
- B. All spaces, pathways, outlets, cables, termination hardware, grounding system and equipment shall be labeled with machine-generated labels.
- C. All labels shall be clear with black text.
- D. All cables shall be labeled with machine generated, wrap around labels.
- E. A total of three (3) labels per horizontal cable are required at the following intervals: 6" from outlet; 18" from outlet' 12" from termination block/patch panel.
- F. Labeling scheme shall be alphanumeric.
- G. Provide and generate all labeling (no labels will be furnished by the owner).
- H. Labels shall be developed and printed using a software program.
- I. Software program and all in-puts shall be turned over to the owner at the end of the project.

3.02 INSTALLATION

- A. All labels shall be installed straight.

- B. Provide labels at locations as indicated on the Drawings and as follows:
1. Outlet face plates
 2. Inside of outlet boxes
 3. Outlet cable inside box
 4. Outlet cable in ceiling above outlet
 5. Outlet cables at poke through entrance on both sides
 6. Outlet cable at rear of patch panel.
 7. Port at rear of patch panel
 8. Port on front of patch panel
 9. Individual fiber strands at rear of patch panel
 10. Backbone cables whenever exposed on minimum 10' intervals
 11. Backbone cable at point of termination
 12. LAN room and main telecommunications room (MR) punchdown blocks (Voice Outlet and Data Backbone blocks)
 13. Ends of any cored cable put in place that is not terminated
 14. On front of racks, cabinets frames, active hardware, multiplexers

3.03 LABELING SCHEME

- A. In general the following items shall receive labeling:
1. Outlets - (EX. Telecom room#. Patch panel #. Port #) or (EX. 139. 1- 3) 139 is the telecommunications room where the cable originates, 1 is the Patch panel #, and 3 is the third port on the patch panel.
 2. Outlet cables
 3. Backbone cables - (CVR=139) copper voice backbone to room 139, 1-25, 26-50, 51-75, etc - 200)
 4. Patch panels - (ex. PP#1, PP#2, etc)
 5. Patch panel ports (each) - (EX. Office room #. Patch panel- Sequential port #) or (EX. 150. 1- 3) 150 is the office room number, 1 is the patch panel and 3 is the third port.
 6. Equipment racks and cabinets - (EX. Rack 1, rack 2, etc)
 7. Voice 110 LAN room blocks
 8. Data Backbone 110 blocks
 9. Ground wires
 10. Active hardware and multiplexers (by owner)

3.04 TEMPORARY LABELS

- A. Provide temporary labels on all outlet cable as it is roughed-in. The bid documents will not show outlet/cable labeling at the time of the cable rough-in. Replace temporary labels with permanent labels after contract documents have been revised.

3.05 TEXT SIZE AND INFORMATION

- A. Text size should be as large and as bold as possible.
- B. Exact text required information is shown on the Drawings.
- C. Refer to Drawings for all outlet, outlet cables, and backbone cables labels.
- D. Refer to the Cover Drawing for exact labeling coding schemes, where applicable.

3.06 LABELING AND REFERENCE CHARTS

- A. Contractor to provide a labeling reference chart(s) indicating the following:
1. Voice backbone termination of pairs at the local telecommunication room (TR) and main telecommunications room (MR).

2. Voice outlet cable pair termination at the TR.
3. Data patch panel outlet port termination.

3.07 AS-BUILT PLAN & FRAME

- A. Provide and mount frame with "as-built" on TR wall, PBX wall and File Server room wall near the data racks or voice blocks, or as indicated on the plans.

END OF SECTION

SECTION 271116 - CABINETS, RACKS, & ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- C. This document describes the products and execution requirements relating to Communications Cabinets, Racks & Enclosures.
- D. Product specifications, general design considerations, and installation guidelines are provided in this document. Locations of telecommunications equipment and typical installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.

1.2 SUBMITTALS

- A. Provide product data.

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install all Equipment Racks.
 - 2. Furnish and install all Equipment Cabinets.
 - 3. Furnish and install all Equipment Shelves.
 - 4. Furnish and install all Backboards.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Standard Equipment Rack manufacturer(s):
 - 1. Chatsworth Products, Inc. Part #55053-503

2.2 TELCO EQUIPMENT RACKS

- A. Equipment Racks
 - 1. The equipment rack shall be constructed of high strength, lightweight bolted aluminum.
 - 2. Unless otherwise specified in the drawings, all Equipment Racks shall be two rail systems.
 - 3. Equipment rack shall have a minimum weight bearing capacity of 1,500 lbs.
 - 4. The vertical rails of the equipment rack shall be equipped with the threaded EIA hole pattern, both front and rear.
 - a. Rack shall be: 7' in Height

- b. Rack shall be no wider than 21"
- c. Rack shall have EIA 19"W threaded mounting holes
- d. Rack color shall be clear.

PART 3 - EXECUTION

3.1 EQUIPMENT RACKS/CABINETS/SHELVES

- A. Equipment racks shall be securely attached to the concrete floor using four (4) 1/2" diameter bolts and associated hardware (anchors & washers) or as required by local codes.
- B. Equipment racks/cabinets/shelves shall be installed as per the requirements specified by the manufacturer's installation guidelines.
- C. Equipment racks/cabinets shall be placed with a minimum clearance of 36 inches in the front and 66 inches in the rear.
- D. All equipment racks/cabinets shall be grounded to the telecommunications ground bus bar.
- E. Mounting screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

3.2 BACKBOARDS

- A. Backboards shall be 3/4" void free plywood. Size of backboard shall be 4' x 8' unless noted differently on Drawings. Backboards shall be painted with two (2) coats of gray fire-retardant paint.

3.3 IDENTIFICATION

- A. Refer to section 270553 for labeling details.

END OF SECTION

SECTION 271119 - COMMUNICATIONS TERMINATIONS, BLOCKS, AND PATCH PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This section describes the products and specification requirements for Telecommunications Rooms (TR) Blocks and Patch Panels
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. Locations of telecommunications equipment and typical installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.

1.2 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
 - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA-568-C.2 – Commercial Building Telecommunications Cabling Standard, current version.
 - 3. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 - 4. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
 - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 - 6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings” pertaining to communication systems.

1.3 SYSTEM DESCRIPTION

- A. This section describes the acceptable products, procedures and best practices for the installation of Communications blocks and Patch Panels.
- B. Telecommunications contractor shall furnish and install all materials necessary for a complete and working system.

1.4 WARRANTY

- A. The Telecommunications contractor must be an approved Ortronics Certified Contractor at a Plus tier (CIP, CIP-Gold, CIP-Platinum, or multi-site/national) and Oasis certified. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the Ortronics Certified Installer Program (CIP). The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by Ortronics; they also shall have at least 1 project manager successfully complete an Ortronics 2-Day Management Certification class, and Berk-Tek Oasis training program. Ortronics/Berk-Tek will extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user.
- B. Telecommunications contractor shall provide labor, materials and documentation according to Ortronics requirements necessary to insure that the Owner will be furnished with a NetClear Warranty of 25 years in length.

- C. All necessary documentation for warranty registration must be provided to Ortronics and Georgia State University Information Systems and Technology Group and will be furnished by the Telecommunications Contractor immediately following 100% testing of all cables. All test results shall be submitted to Ortronics and Georgia State University Information Systems and Technology Group in the certification tester's original software on CD.
- D. Telecommunications Contractor shall administer the warranty process with the responsible manufacturer's representative. The warranty shall be provided directly to the owner from the manufacturer. Telecommunications contractor shall insure that the manufacturer provides the Owner (Georgia State University Information Systems and Technology Group), with the appropriate warranty certification within 30 calendar days of the final project completion.

PART 2 - PRODUCTS

2.1 APPROVALS AND SUBSTITUTIONS

- A. All products shall be provided as specified, without exception, unless approved in writing by Georgia State University Information Systems and Technology Group prior to the bid.
- B. Non-compliant products installed as a part of this Contract shall be removed and replaced and all costs for removal and replacement shall be borne solely by the Contractor(s).
- C. All products shall be "NEW".

2.2 APPROVED PRODUCTS

- A. Approved 48 Port Category 6 Unshielded Twisted Pair Patch Panel
 - 1. Manufacturer: Ortronics
 - a. Part Number: OR-PHD66U48
- B. Approved 12 Port, Optical Fiber Enclosure, Rack Mounted
 - 1. Manufacturer: Corning
 - a. Part Number: CCH-01U
 - b. Multi-Mode Fiber Insert Panel, 6 Port SC Connector - Part Number: CCH-CP06-E7
 - c. Single-Mode Fiber Insert Panel, 6 Port SC Connector - Part Number CCH-CP06-59
- C. Approved 72 Port, Optical Fiber Enclosure, Rack Mounted
 - 1. Manufacturer: Corning
 - a. Part Number: CCH-04U
 - b. Multi-Mode Fiber Insert Panel, 6 Port SC Connector - Part Number: CCH-CP06-E7
 - c. Single-Mode Fiber Insert Panel, 6 Port SC Connector - Part Number CCH-CP06-59
- D. Approved 144 Port, Optical Fiber Enclosure, Rack Mounted
 - 1. Manufacturer ADC/Tyco Electronics
 - a. Left Side: Part Number: NGF-TB4MLU7 or Equivalent Pre-Terminated ADC Unit.
 - b. Right Side: Part Number: NGF-TB1MRU7 or Equivalent Pre-terminated ADC unit.
 - c. Single-Mode Fiber Insert Panel,
- E. Approved Wall-Mounted S110 Field Termination Kits
 - 1. Manufacturer: Siemon
 - a. 50-pair, S110 wiring block with legs - Part Number: S110AW1-50
 - b. 100-pair, S110 wiring block with legs - Part Number: S110AW2-100
 - c. 200-pair, S110 wiring block with legs - Part Number: S110AW2-200
 - d. 300-pair, S110 wiring block with legs - Part Number: S110AW2-300
- F. Approved Wall –Mounted S110 Horizontal Cable Managers
 - 1. Manufacturer: Siemon
 - a. 1 RMS Wire manager with Legs
 - b. Part Number: S110A1RMS

3.0 EXECUTION

- A. Category 6 patch panel terminations shall be compliant with ANSI/TIA 568-C.2.0 standards, and manufacturer recommendations.
- B. Fiber optic patch panel terminations shall be compliant with ANSI/TIA 568-C.3.0 standards, and manufacturer recommendations.
- C. Unless exact location is specified in the drawing set, Contractor shall coordinate the placement of all patch panels with the owner. Georgia State University Information Systems and Technologies.
- D. Unless exact location is specified in the drawing set, the contractor shall coordinate the placement of all Category 6 patch panels with the owner. Georgia State University Information Systems and Technologies.

3.2 Category 6 Patch Panels

- A. General
 - 1. Category 6 Patch Panels shall be compliant with ANSI/TIA 568-C.2.0 standards and manufacturers recommendations.
 - 2. Category 6 Patch Panels shall be compatible with 19" Telco racks, 19" ISO equipment cabinets, or wall mount brackets.
 - 3. The Category 6 patch panel shall be equipped with 8-position modular ports and shall be terminated using a T568B wiring scheme.
 - 4. Unless exact placement of the Category 6 Patch Panel is specified in the drawing sets, the contractor shall coordinate the placement of the Patch Panels with the owner, Georgia State University Information Systems and Technologies.
- B. 48-Port, Category 6 Unshielded Twisted Pair Patch Panels
 - 1. Category 6 unshielded twisted pair patch panel shall be compliant with ANSI/TIA 568-C.2.0 standards.
 - 2. Category 6 unshielded patch panels shall only be used to terminate Category 6 unshielded cables.

3.3 Fiber Optic Patch Panels

- A. General
 - 1. Fiber optic patch panel terminations shall be compliant with ANSI/TIA 568-C.3.0 standards, and manufacturer recommendations.
 - 2. Unless exact placement of Fiber Optic Patch Panels is specified in the drawing sets, the contractor shall coordinate the placement of the patch panel with the owner, Georgia State University Information Systems and Technologies.
- B. Density 24-Port Optical Fiber Termination Panel
 - 1. The 24Port Optical Fiber Termination Panel shall be compatible with 19" equipment Racks, 19" Equipment Cabinets and wall mount brackets.
 - 2. The 24Port Optical Fiber Patch Panels shall be used in all communications closets that have more than 12 or less fiber terminations.
 - 3. The 24Port Optical Fiber Termination Panels shall use SC terminations for both multi-mode and single-mode fiber as listed above.
 - 4. The 24Port Optical Fiber Termination Panels shall use SC Ultra Polished terminations for Single-mode terminations.
- C. High Density 144-Port Optical Fiber Termination Panel
 - 1. The 144 Port Optical Fiber Termination Panel shall be compatible with ADC NGF-MDF7A100-30 Fiber Distribution Frame.
 - 2. The 144 Port Optical Fiber Termination Panels shall be used in all communications closets that have more than 432 fiber terminations in a specific location.

3. The 144 Port Optical Fiber Termination Panel shall use LC Ultra polished connectors for Single-Mode fiber terminations.

3.4 S110 Wall Mount Field Termination Units

- A. Wall Mount Field Termination Units shall be mounted in a level horizontal position.
- B. Wall Mount Field Termination Units shall have approved horizontal cable managers installed on top and bottom of all units.
- C. Wall Mount Field Termination Units shall have approved Vertical Cable Managers installed in all applicable positions.
- D. Wall Mount Field Termination Units shall have cable labeling strips installed on all units.
- E. Wall Mount Field Termination Units shall be mounted no lower than 2' from the ground.
- F. Unless specified on the drawings, the location for mounting of Wall Mount S110 Field Termination Units shall be coordinated with the owner, Information Systems and Technology.

END OF SECTION

SECTION 271123 - COMMUNICATIONS CABLE MANAGEMENT & LADDER RACKS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- C. This document describes the products and execution requirements relating to Communications Cable Management & Ladder Rack.

1.2 SUBMITTALS

- A. Product data.

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install all Horizontal Cable Management.
 - 2. Furnish and install all Vertical Cable Management.
 - 3. Furnish and install Ladder Rack System.
 - 4. Furnish and install all Velcro Straps.
 - 5. Furnish and install all C-Rings/D-rings.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Horizontal Cable Management manufacturer(s):
 - 1. Superior Modular Part Number: COMB3519
- B. Approved Vertical Cable Management manufacturer(s):
 - 1. Chatsworth Products, Inc. Part Number: 11729-503
- C. Approved Ladder Rack System manufacturer(s):
 - 1. Chatsworth Products, Inc.
 - 2. B-Line
- D. Approved Velcro Strap manufacturer(s):
 - 1. Panduit
- E. Approved C-Ring/D-ring manufacturer(s):
 - 1. Siemon Part Number: S144

2.2 CABLE MANAGEMENT - HORIZONTAL

- A. Horizontal Cable Management
 - 1. The horizontal wire manager shall be compatible with 19-inch equipment racks and cabinets.
 - 2. The horizontal cable manager shall provide support for patch cords at the front of the panel.

3. The horizontal wire manager shall be equipped with management fingers and covers.
4. The horizontal cable manager shall be 2 rack-units in height.

2.3 CABLE MANAGEMENT - VERTICAL

- A. Vertical Cable Management
 1. The vertical cable manger shall be double-sided.
 2. The vertical cable manager shall provide support for patch cords at the front of the rack and wire management at the rear of the rack.
 3. The vertical cable manager shall be a minimum width of 6".
 - a. Vertical Cable Manager color shall be gray.

2.4 LADDER RACKS

- A. Ladder Rack System
 1. See Drawings for ladder rack system details.
 2. The ladder rack system shall be securely mounted with hardware designed for use in ladder rack systems.
 3. End caps shall be installed on the exposed ends of the ladder racks, channel supports and bolts. Protective covers shall be installed on threaded rods that come in contact with cabling plant.
 - a. Ladder Rack System color shall be gray.

2.5 VELCRO STRAPS

- A. Velcro Straps
 1. All cables shall be fastened to support structures with Velcro straps.
 - a. Velcro Strap color shall be black.

2.6 C-RINGS/D-RINGS

- A. C-Rings/D-rings
 1. C-rings/D-rings shall be used on backboards to support cables, patch cords and cross-connect wire.
 2. C-rings/D-rings shall be made of high-strength, fire-retardant material with rounded edges to prevent damage to cable and wire insulation.

2.7 LADDER RACK DROP-OUT SHIELD

- A. Ladder Rack Drop-Out Shield
 1. Ladder rack drop-out shield used to protect cables as they are routed from ladder rack to equipment rack shall be custom made by Star Sheet Metal (214) 438-5056.

PART 3 - EXECUTION

3.1 CABLE MANAGEMENT - HORIZONTAL

- A. Horizontal cable managers shall be installed below patch panels in a 1:1 ratio (one horizontal cable manager per patch panel) or as indicated on Drawings.

3.2 CABLE MANAGEMENT - VERTICAL

- A. Vertical cable managers shall be installed on both sides of a single equipment rack. Where two (2) or more racks are positioned in a row, vertical cable managers shall be installed between each rack and each end of the row.

3.3 LADDER RACKS

- A. Ladder rack system shall be installed straight, level and perpendicular to walls and ceiling slabs.
- B. Ladder racks shall be supported at 5' intervals maximum.
- C. Provide all hardware, accessories, fasteners, anchors, threaded rods and support channels required to provide a complete ladder rack system.
- D. See Drawings for ladder rack system details.

3.4 VELCRO STRAPS

- A. Velcro straps shall be installed around cables at intervals of 12" minimum.
- B. Do not over-cinch cables.

3.5 C-RINGS/D-RINGS

- A. C-ring/D-rings shall be installed on 3/4" backboard, straight and level.

3.6 LADDER RACK DROP-OUT SHIELD

- A. Install in ladder rack above equipment racks to support cables as they are routed from the ladder rack to the equipment rack.

3.7 IDENTIFICATION

- A. Refer to section 270553 for labeling details.

END OF SECTION

SECTION 271126 - COMMUNICATIONS RACK MOUNTED POWER STRIPS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- C. This document describes the products and execution requirements relating to Communications Rack Mounted Power Strips.

1.2 SUBMITTALS

- A. Provide product data

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Furnish and install all Power Strips.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Power Strip manufacturer(s):
 - 1. Chatsworth Products, Inc.
 - 2. Ditek
 - 3. Geist
 - 4. ITW Linx

2.2 POWER STRIPS

- A. Power Strip
 - 1. The power strip shall be equipped with a minimum of six (6) 3-prong, 120 VAC outlets, 12' cord and an on/off switch.
 - 2. The power strip shall be equipped with surge protection with a 20 Amp current limit.
 - 3. The power strip shall be equipped with a bracket that enables it to be mounted on a 19" rack, cabinet or wall mount bracket without modification.

PART 3 - EXECUTION

3.1 POWER STRIPS

- A. Power strips shall be installed as per the requirements specified by the manufacturer's installation guidelines.

- B. See Drawings for installation location on rack(s)/cabinet(s).

3.2 IDENTIFICATION

- A. Refer to section 27 05 53 for labeling details.

END OF SECTION

SECTION 271313 - COMMUNICATIONS COPPER BACKBONE

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Applicable requirements of Division 27 Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- C. This document describes the products and execution requirements relating to Communications Copper Backbone. Provide a complete and operational system as specified here-in.
- D. Product specifications, general design considerations, and installation guidelines are provided in this document. Locations of backbone cabling and typical installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.

1.2 SUBMITTALS

- A. Provide product data

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Provide all Copper Backbone Cable (Inside Plant).

PART 2 - PRODUCTS

2.01 APPROVED PRODUCTS

- A. Approved Copper Backbone Cable (Inside Plant) manufacturer(s):
 - 1. Berk-Tek

2.02 COPPER BACKBONE CABLE (INSIDE PLANT)

- A. 100-Ohm, Balanced Twisted Pair Building Backbone Cables (Inside Plant)
 - 1. Generic Characteristics:
 - a. The inside plant building backbone cable shall meet 100-Ohm, balanced twisted pair backbone cable requirements per the latest issue of ANSI/TIA/EIA-568-C.2.
 - b. The inside plant 100-Ohm, balanced twisted pair cable shall be CMP rated.
 - c. The inside plant building backbone cable core shall consist of 25-pair sub-units.

PART 3 - EXECUTION

3.01 BACKBONE CABLES (INSIDE PLANT)

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-C.2 document, manufacturer's recommendations and best industry practices.
- B. Backbone cables shall be installed separately from horizontal distribution cables
- C. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- D. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
- E. Exposed cables must be CMP rated.
- F. Where backbone cables and horizontal cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.
- G. Leave 10' of slack on each end of copper backbone cable.
- H. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.
- I. Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.
- J. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.
- K. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- L. Copper cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- M. Each copper cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support straps. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.03 IDENTIFICATION

- A. Refer to section 270553 for labeling details.

END OF SECTION

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section
- B. This document describes the products and execution requirements relating to Communications Optical Fiber Backbone Cabling. Provide a complete and operational system as specified herein.
- C. Product specifications, general design considerations, and installation guidelines are provided in this document. Locations of backbone cabling and typical installation details will be provided on Drawings as an attachment to this document. If the bid documents are in conflict, the Drawings shall take precedence. The successful vendor shall meet or exceed all requirements described in this document.

1.2 SUBMITTALS

- A. Contractor shall provide submittals indicating the following:
 - 1. Cable description
 - 2. Use of cable
 - 3. Product data
 - 4. Specifications outlining cable
 - 5. Testing and qualification data
 - 6. Samples, approximately 12" in length

1.3 WORK INCLUDED

- A. The work included under this Specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete the installation. The Contractor will provide and install all of the required material whether specifically addressed in the technical specifications or not.
- B. The work shall include, but not be limited to the following:
 - 1. Provide all Optical Fiber Backbone Cable (Inside Plant).
 - 3. Furnish and install all Optical Fiber Connectors.
 - 4. Perform all Optical Fiber Splices.
 - 5. Provide all Splice Cases.

PART 2 - PRODUCTS

2.1 APPROVED PRODUCTS

- A. Approved Optical Fiber Backbone Cable (Inside Plant) manufacturer(s):
 - 1. Corning
 - 2. Uniprise (CommScope)
- B. Approved Optical Fiber Connectivity manufacturer(s):
 - 1. Corning Part Number: 95-050-41-X
- C. Approved Splice Case manufacturer(s):

1. Corning
2. Uniprise (CommScope)

2.2 OPTICAL FIBER BACKBONE CABLE (INSIDE PLANT)

- A. Plenum - Indoor Distribution 50/125 Multimode Optical Fiber Non-Conductive (OFNP) Tight Buffered Cable
 1. Generic Characteristics:
 - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
 - b. The indoor optical fiber cable shall have sequential length marking printed on the cable jacket.
 - c. Maximum attenuation dB/Km @ 850/1300 nm: 3.5/1.5
 - d. Bandwidth 500 MHz-km @ 850 nm.
 - e. Bandwidth 500 MHz-km @ 1300 nm.
 - f. Type OM3
- B. Plenum - Indoor Distribution 8.3/125-micron Singlemode Optical Fiber Non Conductive (OFNP) Tight Buffered Cable
 1. Generic Characteristics:
 - a. The indoor optical fiber cable shall be available with up to twelve 900-micron tight-buffered, 250-micron fibers placed in a color-coded sub-unit bundle with aramid strength elements.
 - b. The indoor optical fiber cable shall have sequential length markings printed on the cable jacket.
 - c. All singlemode fibers shall be pigtail spliced into a rack mounted optical fiber enclosure or wall-mounted enclosure.
 - d. The loss of fiber shall not exceed 1.0 dB per kilometer @ 1550 nm and 1.0 dB per kilometer @ 1310 nm.

2.4 OPTICAL FIBER CONNECTORS

- A. Multimode Fiber Connectivity:
 1. The optical fiber field-installable connector shall be SC format, for installation onto either multimode 50/125-micron fiber.
 2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
 3. The optical fiber field-installable connector shall have a maximum Loss of .5 dB.
 4. The optical fiber field-installable connector shall have a typical Reflectance of -30 dB.
- B. Singlemode Fiber Connectivity:
 1. The optical fiber field-installable connector shall be SC format, for installation onto singlemode 8.3/125-micron fiber.
 2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
 3. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.
 4. The splice loss through each connector pair shall not exceed 0.50 dB.
 5. All singlemode connectors (pigtails and field terminated) shall be SC.

PART 3 - EXECUTION

3.1 GENERAL GUIDELINES

- A. Provide optical fiber cable from each telecommunications room (TR) to the main telecommunications room (MR). Refer to drawings for exact counts. Optical fiber cable shall be installed inside buildings using the same methods as twisted pair; however, the manufacturers' guidelines regarding the following should be observed:
 - 1. Do not exceed the manufactures maximum pulling tension.
 - 2. Do not exceed minimum installed and long term bend radius.
 - 3. Avoid sharp bends and corners.
 - 4. Provide additional crush/mechanical protection in high-risk environments.
 - 5. Do not exceed maximum vertical rise specification unless intermediate tension relief is used.
 - 6. Observe all governing building and fire codes (either by using a properly listed cable or suitable raceway).
 - 7. Secure the optical fiber cable to existing supports or large cables wherever possible.
 - 8. Do not deform the cable jacket, specifically when using Velcro straps.

3.2 OPTICAL FIBER INSTALLED IN CABLE TRAYS / LADDER RACKS

- A. Install optical fiber cable so as to minimize potential damage when additional cables are installed or retrieved. (install fiber to one side of the cable tray or cable rack, limiting contact with other cables)
- B. Maintain minimum bend radius around corners through the use of a fiber guide.
- C. All optical fiber cabling shall be routed in innerduct or conduit
- D. Secure cable to tray every 12" to 24."

3.3 OPTICAL FIBER INSTALLED IN VERTICAL RUNS

- A. Work from the top down, when possible.
- B. Secure the cable in innerduct every 24 to 36 inches to cable rack tray.
- C. Install intermediate split wire mesh grip(s) wherever the maximum vertical rise is exceeded.
- D. Secure the cable in the backbone cabling in telecommunications rooms (TR) with Velcro straps as needed to prevent accidental damage to cable.

3.5 TERMINATION POINTS

- A. The amount of cable slack at termination points should allow the cable to be routed to the termination location with enough additional cable to reach a convenient location for the polishing, plus an additional 5 meters or to the furthest point in the telecommunications room; whichever is greater.
- B. Termination hardware should be located to allow convenient use, convenient termination, and facilitate routing of additional locations.
- C. When routing cable into an equipment rack/cabinet, the minimum bend radius should be maintained in the transition from the floor or ceiling to the rack or cabinet with the use of flexible conduit and a box end connector.
- D. In equipment racks, the cable should be secured to the frame with Velcro straps to prevent accidental snagging of the cable. The use of innerduct is required.

- E. Optical fiber warning signs should be placed on all innerducts and conduits containing optical fiber cable. Warning signs can help prevent damage resulting from the cable being mistaken for something else.

3.6 INSTALLATION

- A. Yellow or other pulling compound should be used if making long or difficult pulls to reduce cable drag.
- B. When pulling optical fiber cable by any mechanical device (winch etc.) a dynamometer must be used to ensure the maximum tensile strength isn't exceeded.
- C. The mechanical pulling device will be equipped with clutches or shear pins to ensure this.
- D. The fiber cable will be attached to the pull line via the strength member or mesh grip.
- E. At each end of a cable run approximately 5 meters of slack should be left for cable repairs, connecting and moving of equipment. Coil up and provide support of any slack fiber on top of the rack or in the designated fiber slack area of the telecommunications room.

3.7 OPTICAL FIBER CONNECTIVITY

- A. Provide and install a "duplex-SC" connector, onto each pair of transmit/receive strands of each end of each cable.
- B. Follow Manufacturers instructions for installing each connector.
- C. Leave a minimum of 5'-0" of slack of each strand coiled carefully in patch panel tray.

3.8 OPTICAL FIBER SPLICING

- A. All splicing shall be of the fusion type made under Light Injection and Detection Mode, whenever applicable. The Contractor shall provide certified and experienced personnel for splicing.
- B. Contractor's tools and equipment shall be in excellent working order. Any worn or improperly working tools shall be discarded and not used on this project. All fusion splicers shall be calibrated and labeled according to the manufacturer's specifications. Contractor shall submit certification of calibration for the fusion splicers to the Engineer.

3.9 ACCESSORIES

- A. Install outer door to complete installation.
- B. Along with above specifications use installation product bulletins which accompany each product.

3.10 IDENTIFICATION

- A. Provide labeling of each cable and each termination. Submit method of labeling for approval. Refer to section 270553 for labeling details.

END OF SECTION

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Horizontal (distribution) communications wiring and connecting hardware from the Telecommunications Room (TR) to Telecommunication Outlets (TO) throughout the site.
- C. Provide a complete and operational system as specified here-in.

1.2 REFERENCES

- A. All work shall be performed in accordance with the following codes and industry standards, unless noted otherwise:
 - 1. NFPA 70 – National Electrical Code, current version adopted by local or State AHJ.
 - 2. TIA-568-C.2 – Commercial Building Telecommunications Cabling Standard, current version.
 - 3. TIA/EIA-569-B – Commercial Building Standard for Telecommunications Pathways and Spaces, current version.
 - 4. TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure, current version.
 - 5. J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, current version.
 - 6. IEEE 241 - IEEE Recommended Practice for Electric Power Systems in Commercial Buildings” pertaining to communication systems.

1.3 SYSTEM DESCRIPTION

- A. The horizontal distribution subsystem refers to all intra-building twisted-pair and fiber optic communications cabling connecting Telecommunication Rooms (TR's) to telecommunication outlets (TO's) located at individual work areas.
- B. Horizontal cabling may consist of a combination of the following types of cable from the TR to the TO:
 - 1. Category 6 (100 Ohm, 4-pair, unshielded twisted pair) cables from the TR's to the TO's.)
- C. The Horizontal System includes cables, jacks, patch panels, connecting blocks, patch cords, fiber connectors and jumpers as well as the necessary support systems, such as cable managers and faceplates.

1.4 WARRANTY

- A. The Telecommunications contractor must be an approved Ortronics Certified Contractor at a Plus tier (CIP, CIP-Gold, CIP-Platinum, or multi-site/national) and Oasis certified. The Telecommunications contractor is responsible for workmanship and installation practices in accordance with the Ortronics Certified Installer Program (CIP). The certified contractor shall have 30% of their technicians trained on copper & fiber installations and testing by Ortronics; they also shall have at least 1 project manager successfully complete an Ortronics 2-Day Management Certification class, and Berk-Tek Oasis training program. Ortronics/Berk-Tek will extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user.

- B. Telecommunications contractor shall provide labor, materials and documentation according to Ortronics requirements necessary to insure that the Owner will be furnished with a NetClear Warranty of 25 years in length.
- C. All necessary documentation for warranty registration must be provided to Ortronics and Georgia State University Information Systems and Technology Group and will be furnished by the Telecommunications Contractor immediately following 100% testing of all cables. All test results shall be submitted to Ortronics and Georgia State University Information Systems and Technology Group in the certification tester's original software on CD.
- D. Telecommunications Contractor shall administer the warranty process with the responsible manufacturer's representative. The warranty shall be provided directly to the owner from the manufacturer. Telecommunications contractor shall insure that the manufacturer provides the Owner (Georgia State University Information Systems and Technology Group), with the appropriate warranty certification within 30 calendar days of the final project completion.

PART 2 - PRODUCTS

2.1 STATION CABLING

- 1. Approved Copper Station Cable Manufacturer(s):
 - 1. Berk-Tek
 - 2. Belden
 - 3. CommScope
 - 4. Mohawk
 - 5. Superior-Esse

2.2 ACCEPTABLE STATION CABLING TYPES

- 1. Category 6 unshielded twisted pair
 - 1. 100 ohm, Category 6, 23AWG, 4-pair unshielded twisted pair, CMP rated, color blue.
 - 2. The horizontal balanced twisted pair cable shall meet or exceed the Category 6 transmission characteristics per ANSI/TIA-568-C.2.

3.0 EXECUTION

- A. Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
- B. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- C. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type.
- D. Cables shall be installed in continuous lengths from origin to destination (no splices).
- E. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- F. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- G. Horizontal distribution cables shall be bundled in groups of no more than 50 cables.
- H. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices

- I. Cables shall be routed through conduit, cable trays, spaces below raised floors, open ceiling areas, non-ventilated spaces above ceiling tile, and through plenum air-handling spaces above ceiling tile. Coordinate with General Contractor (GC).
- J. Cables shall not be attached to ceiling grid, fire sprinkler systems, duct work, or lighting fixture supports or cables. Where support is required the contractor shall install appropriate support systems as prescribed in ANSI/TIA-568.C.2.
- K. Cables shall be installed in continuous lengths from origin to destination point. There shall be no splices.
- L. Horizontal cables shall not be bundled in groups of more than 50 cables.
- M. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 Lbs) shall be installed with any cable installed in conduits. A pull cord is not required for conduit sleeves, of less than 4' in length.
- N. Contractor shall leave a minimum of 12" of slack for twisted pair out the outlet end. This slack shall be neatly coiled in the wall, termination box, or modular furniture raceway. Where there is insufficient space in the wall, termination box, or modular furniture raceway, the required slack may be left loosely coiled in the ceiling area.
- O. Each cable shall be clearly labeled on the cable jacket behind the termination device at each location.

END OF SECTION

SECTION 283111 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Programming of Fire Alarm Control Panel(s).
 - 2. Notification device, power supply, booster panels.
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Heat detectors.
 - 7. Notification appliances.
 - 8. Magnetic door holders.
 - 9. Addressable interface monitoring and control device(s).
 - 10. System calculations.
 - 11. System performance verification.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.
- C. HVAC: Heating, Ventilation and Air Conditioning.
- D. CIS: Common intelligibility scale.

1.4 SYSTEM DESCRIPTION

- A. Fire detection and alarm system is existing Simplex 4100 series voice evacuation system. Work consists of new devices and hardware and programming for new devices.
- B. System Design
 - 1. Provide a complete design for the fire alarm system.
 - 2. System design shall be prepared and sealed by a professional engineer as specified here-in.
 - 3. System addition shall comply with all applicable codes and standards for the State of Georgia, City of Atlanta and Georgia State University including all codes and standards referenced by the above.
 - 4. Coordinate with Division 23 requirements for smoke control. Coordinate with mechanical design drawings.
 - 5. Coordinate with Division 21 requirements for sprinkler system devices. Coordinate with sprinkler design drawings.
 - 6. Coordinate with Division 8 requirements for door hardware. Coordinate with architectural design drawings.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product required.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, calculations and attachments to other work.
 - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

2. Provide voltage drop calculations for notification appliance circuits.
 3. Provide battery-size calculations for all existing elements impacted by this renovation and new equipment.
 4. Provide sound pressure level calculations for all common spaces, as defined by ADA, and 20% of all other spaces (i.e. offices).
 5. Provide sound intelligibility calculations for all common areas, as defined by ADA, and 20% of all other spaces (i.e. offices).
 6. Provide performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 7. Provide plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 8. Provide voice/alarm signaling-service control layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 9. Provide floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- C. General Permit Drawings And Submittal Requirements:
1. Permit drawings shall be prepared and sealed, dated and signed by a Georgia State Registered Professional Engineer and approved by authorities having jurisdiction prior to submitting them to Architect.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data, include the following:
1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 3. Record copy of site-specific software.
 4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
 5. Manufacturer's required maintenance related to system warranty requirements.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from Simplex-Grinnell. Components shall be compatible with, and operate as, an extension of existing system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Certification: Provide certification according to NFPA 72.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements required:
 - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.9 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products from SimplexGrinnell LP; a Tyco International company.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. System operation shall remain as-is, unless required to be modified by this renovation.

2.3 FIRE-ALARM CONTROL UNIT

- A. Fire-Alarm Control Unit is existing and must be upgraded to meet new building and occupant requirements.
- B. Provide a modules, interfaces, devices, software, etc. required to expand the fire alarm control unit for this renovation.

2.4 PERIPHERAL DEVICES

- A. Match existing units pull stations, smoke detectors, duct detectors, control devices, monitoring modules, speakers and strobe lights currently installed in the last renovation.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
 - 1. Connect new equipment to existing control panel in existing part of the building.
 - 2. Connect new equipment to existing monitoring equipment at the supervising station.
 - 3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- D. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
 5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.
- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.
- F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- G. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- H. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements and compatibility for door hardware. Connect hardware and devices to fire-alarm system.
1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 3. Smoke dampers in air ducts of designated air-conditioning duct systems.
 4. Alarm-initiating connection to elevator recall system and components.
 5. Supervisory connections at valve supervisory switches.
 6. Supervisory connections at elevator shunt trip breaker.
 7. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition (future construction phase).

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents,

- Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
- b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
- 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 3. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 5. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
 - C. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

